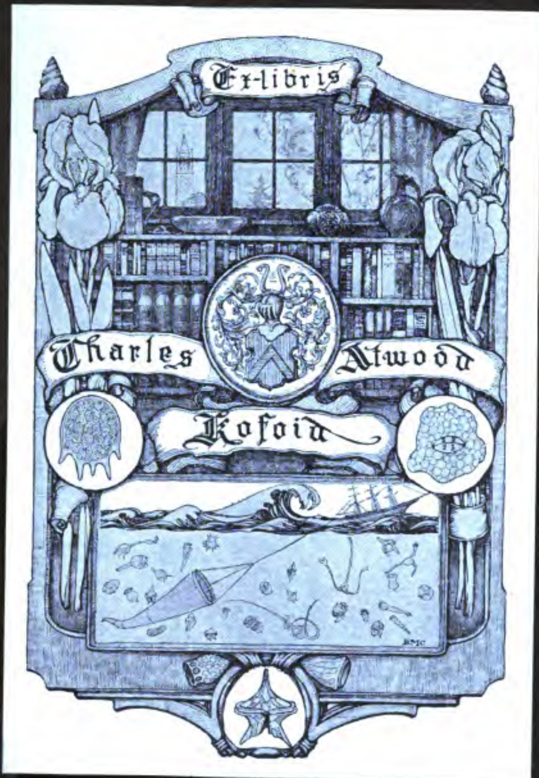
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SCIENCE AND COMMERCE:

Their Influence on our Manufactures;

A SERIES OF

STATISTICAL ESSAYS AND LECTURES

DESCRIBING THE PROGRESSIVE DISCOVERIES OF SCIENCE,
THE ADVANCE OF BRITISH COMMERCE,
AND THE CONDITIONS OF OUR PRINCIPAL MANUFACTURES IN THE
NINETEENTH CENTURY.

BY

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PREFACE.

HAVING been solicited to publish some lectures recently delivered on the Products of Commerce (forming the Travers' Course) at the London Institution, I have availed myself of the opportunity to reprint at the same time, in a compact volume, a few of the many articles I have contributed to the commercial literature of the day on kindred topics during the last twenty years. It appeared to me that there was a want of a reliable handy-book of reference on our commerce and manufactures, and some observations which I made in the preface to my "Commercial Dictionary of Trade Products," published fourteen years ago, are even more pertinent now. "The present is essentially a practical, commercial, and industrial age—newspapers, lecturers, popular authors—all lend their efforts towards the diffusion of sound and useful knowledge among the masses; and the commercial and industrial element has become the leading feature of instruction.

"The reason of this is obvious, if we but glance at the amazing strides of British Commerce, the wide

range of Products and Manufactures in which we are interested, the constant and rapid intercommunication carried on with foreign countries, and the progress of settlement in our colonies. The trade and commerce of all nations are now daily brought before us prominently through the press; new products are continually introduced, new trades are established, and the raw materials of commerce now imported are so numerous, and so widely different from what they were a quarter of a century ago, that it is difficult for those who are not specially engaged in a particular trade to keep pace with the general information necessary to be acquired."

I have selected from my published articles only those which bore specially on scientific discovery, commerce and manufactures; but although the volume has swelled beyond the usual limits, I have been able to include but a portion; should the work, however, meet with public approval, I may publish a second volume of kindred papers and contributions to publications, many of which are now extinct or not generally accessible.

Although my literary and professional engagements have prevented me from re-writing and condensing (as I could have wished) many of these treatises, I have

at least supplemented them, and brought down the statistical and general information to the present time. Therefore, all that the reader has to do in consulting them is to bear in mind the original date of publication, which is given at the commencement of each article.

It is not every one who has had such extensive commercial experience and long facilities of research and observation in the arrangement of Technological Museums and International Exhibitions at home and abroad, as I have, and possibly, therefore, some of the remarks and information published in this volume may prove useful for instruction and reference.

P. L. SIMMONDS.

29, *Cheapside, London, E.C.,*
July, 1872.

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NOTE.—The paragraphs within brackets and the appended foot-notes have been added to bring down the information to the present time.

SCIENCE AND COMMERCE:

THEIR INFLUENCE ON OUR MANUFACTURES.

TRAVERS' COURSE.*

LECTURE I.

OBLIGATIONS OF COMMERCE TO SCIENCE; AND THE VEGETABLE PRODUCTS IMPORTED.†

THE subject on which I have to address you comes home directly to every one of us, for it ministers

* "The public services of the late John Travers having led to the collection of a fund for the purpose of presenting to him a testimonial, he determined that the money so raised, instead of ministering to his own pleasure or aggrandisement, should be set apart for some object of public utility, and being placed in the hands of trustees, it was transferred to this institution as the foundation for lectures on Commerce and Commercial Law. These were commenced on May 21, 1856, and two lectures have been given each session in fulfilment of this trust. Mr. John Young, Professor Fawcett, and others have delivered these lectures, which, till this year, have been more especially directed to the *law* of Commerce. This year Mr. P. L. Simmonds has awakened much interest by taking the Articles of Commerce as his subject."—*Introductory address of Mr. Thomas Piper, Hon. Sec., Dec. 7,* 1871, *in "Journal of the London Institution," Jan.* 16, 1872.

† Delivered at the London Institution, Finsbury Circus, November 23rd, 1871. The lectures were illustrated by large

largely to our individual comfort, and contributes greatly to our national wealth. Meeting, as we do, in the hall of an old established scientific institution, located within the business centre of this great commercial capital,—a city which comprises one-tenth of the population of the entire kingdom, and by its immense traffic with foreign and distant parts, its interchange of commodities with every quarter of the globe, is the busiest, most enterprising, and most wealthy emporium of either ancient or modern times—it seems scarcely necessary to urge any plea for the nature of the subject *—

> Here Commerce spreads on every sea her sail,
> And ploughs the wave before each passing gale.
> Here, 'mid the city's hum, the merchant stands,
> And holds the thread connecting distant lands:
> He speaks the word—at his commanding will,
> The thousand wheels of Industry are still!
> He speaks the word—and at his will, once more
> The sails of Commerce whiten every shore!

and interesting collections of Trade Products, furnished by various leading merchants and brokers, and from Mr. Simmonds's own private collection in his Trade Museum, 29, Cheapside.

* Mr. Piper, the Honorary Secretary of the Institution, in a subsequent address, remarked :—

"Science and Literature are common properties, and offer wide fields for research and enjoyment, but the connection of *Science with Commerce* seems more especially to belong to an institution founded in the midst of a mercantile community. It especially occupied the thoughts of those who originated this institution, and was the theme of the eloquent inaugural address delivered by the Standing Counsel (Mr. C. Butler), when the first stone of the building in which we are assembled was laid."

Remember that we are an insular country, in a temperate climate, and that our population—in the main prosperous and wealthy—is fast outgrowing our local means of subsistence. Picture to yourself for a moment what would be our condition supposing this island were subject to a blockade for a few months. I do not say this is possible; but we do know that in adverse times we have had to encounter a famine in Ireland, deficiencies of cotton from America, of Russian supplies of tallow, hemp, and bristles, and a dearth of silk from disease. But, if hemmed in by foes, how many supplies of the raw materials for our mills, how many comforts—indeed, what we now term the necessaries of life, such as tea, coffee, cocoa, sugar, tropical fruits, wines—should we miss; whilst even our grain, dairy produce, and animal food supplies would be found utterly insufficient for our wants.* The products of the mine, the factory, and the farm

* How greatly the world would be benefited by unlimited facilities for transportation and exchange of goods is shown by the fact that, while the people of Persia are starving by tens of thousands, the inhabitants of some of our Western States are burning corn in their stoves in place of coal.—"*Scientific American*," *January*, 1872.

The following extract from the Hon. Edward Everett's address before the New York State Agricultural Society, in 1857, is well worth reproducing :—

"Strike out of existence, at once, ten days' supply of eight or ten articles, such as Indian corn, wheat, rye, potatoes, rice, millet, the date, the banana, and the bread-fruit, with half-a-dozen others which serve as the forage of the domestic animals, and the human race would be extinct. The houses we inhabit, the monuments we erect, the trees we plant, stand in some cases for ages; but our own frames—the stout

are concentrated in the warehouses of our docks. The corn-fields of America and Europe, the rice-fields of Asia, the sugar-cane pieces of the East and West Indies, the coffee plantations and the spice groves of the Tropics, the fleeces of the sheep of Africa, Australia, and South America, of the alpaca of the Andes and the goat of Cashmere, the gold of America and Australia, the iron of Sweden and the Black Forest, the copper of America and Australia; the ship, the ironworks, the engine-makers' workshop, the bazaar, the exchange, the market,—all these, and many more multifarious forms of industry and com-

limbs, the skilful hands that build the houses, and set up the monuments, and plant the trees,—have to be built up, re-created, every day; and this must be done from the fruits of the earth, gathered by agriculture. Everything else is luxury, convenience, comfort—food is indispensable. Then consider the bewildering extent of this daily demand and supply, which you will allow me to place before you in a somewhat coarse mechanical illustration. The human race is usually estimated at about one thousand millions of individuals. If the sustenance of a portion of these multitudinous millions is derived from other sources than agriculture, this circumstance is balanced by the fact that there is a great deal of agricultural produce raised in excess of the total demand for food. Let, then, the thoughtful husbandman who desires to form a just idea of the importance of his pursuit, reflect, when he gathers his little flock about him to partake the morning's meal, that one thousand millions of fellow-men have awakened from sleep that morning, craving their daily bread, with the same appetite which reigns at his family board; and that if, by a superior power, they could be gathered together at the same hour, for the same meal, they would fill both sides of five tables reaching all round the globe where it is broadest, seated side by side, and allowing

merce, are represented in our import and export trade returns. In the words of Cowper:—

> The band of Commerce was designed
> To associate all the nations of mankind;
> And if a bounteous plenty be the robe,
> Trade is the golden girdle of the globe.

My lamented friend, Professor George Wilson, in one of his lectures on Technology, well observes that—

"One of the greatest services which Observational Science is continually rendering to Industrialism is the discovery of natural substances, mineral, vegetable, and animal possessed of useful but latent properties. A service not less great is then rendered by Transformational Science, pointing out how to modify this gift of nature so as to call into active existence hidden precious qualities. Thus, to take a complex but striking ex-

eighteen inches to each individual, and that these tables are to be renewed twice or thrice every day. Then let him consider that, in addition to the food of the human race, that of all the humble partakers of man's toil—the lower animals—is to be provided in like manner. These all wait upon agriculture, as the agent of that Providence which giveth them their meat in due season; and they probably consume in the aggregate an equal amount of produce; and, finally, let him add, in imagination, to this untold amount of daily food for man and beast, the various articles which are furnished, directly or indirectly, from the soil, for building material, furniture, clothing, and fuel. The grand total will illustrate the primary importance of agriculture, considered as the steward —the commissary—charged with supplying this almost inconceivable daily demand of the human race and the subject animals for their daily bread; a want so imperative and uncompromising, that death, in its most agonising form, is the penalty of a failure in the supply."

ample, through Observational Science we may discover a soil more or less fertile all the world over, but Transformational Science must show us how to fence and till it, how to drain or irrigate and manure it, before it can be made a fruitful field. Geology, striving ever to reach nearer to the centre of the earth, finds coal for us; Chemistry teaches us how to cook, *i.e.*, literally to cook, this raw material, and how to distil it into naphtha and gas. Mineralogy selects iron ores for us, Chemistry converts them into steel, and Mechanics forges that into bars. Descriptive Botany plucks a wild currant, Physiological Botany changes it into a sweet grape, Chemistry ferments it into wine and transforms that into ether. Descriptive Zoology lays its hands on a caterpillar, Physiological Zoology nurses it into a strong silkworm, Chemistry bleaches and dyes the silk which it spins, and Mechanics weaves it into velvet."

Dr. Yeats, in his recent popular work on "The Natural History of Commerce," also truly remarks that—

"Without a considerable knowledge of raw materials and of their adaptations, we could not live; and without an unremitting application of such knowledge we could not live in comfort. We may even measure a country's civilisation by the extent and diffusion of this important knowledge. The economic history of a nation would be a record of the discovery of new raw materials, of new sources of supply, and of additional applications. All such discoveries tend to our benefit, while their result is occasionally to enrich the discoverer, and to change the face of our social and industrial life.

"We have only to contrast the present period of our history with any former period, or the condition of any one country with another to perceive the effect of such knowledge upon human well-being. Every year adds to our list of useful animal, vegetable and mineral substances, while the increasing consumption of those already known calls forth, as a rule, increased production. Thus, the importance of a knowledge of raw materials cannot be overrated. It is a matter of personal interest to everybody in every part of the world."

What a field of investigation and research, what opportunities for manufacturing industry and skill are opened up in the enormous home and foreign commerce of this our little kingdom!

In the commencement of the present century our Foreign trade (imports and exports) was only to the value of £60,000,000 sterling; now it amounts to £487,500,000—the average figures of the last three years. What a contrast are the imports of the United Kingdom, now of the value of £327,000,000 (1871), in comparison with those of the year 1354, when with the customs' dues thereon they only amounted to £39,000!

The third quarter of the nineteenth century marks an era in our commercial greatness to which many causes have contributed. Among the principal of these may be enumerated the following:—The important gold discoveries of California and Australia, which gave an amazing impetus to emigration and colonisation, for since 1850 the registered emigrants have numbered 4,250,000, exclusive of those by pri-

vate passenger ships; the repeal of our navigation laws; the free trade policy adopted; and the removal of almost all duties, except on a few principal articles for revenue purposes.

I do not intend to enlarge on the laws which affect Commerce, because this is a department which has already been prominently dwelt upon in the Travers' course of lectures. If I had time for this there are very many points, however, which might be adverted to, especially the repeal of the corn laws, the modifications of our bankruptcy law, the laws of partnership, the patent laws and registration of designs act, and, lastly, the protection of British trade marks abroad, which with other important commercial concessions in respect to duties, have been gradually introduced into our successive treaties with foreign nations.

Since the first discoveries of gold in California, Australia, New Zealand, and other quarters, at least £500,000,000 sterling of gold have been added to the previous stock in circulation in the world. The value of the gold coined at the British mint in the fifteen years ending 1854 (that was just after the time of the first gold discoveries) was £65,500,000, and in the fifteen years ending 1869, £76,500,000; so that an average of more than £4,500,000 of gold coin is annually put into circulation in the United Kingdom, exclusive of what is used in the arts and manufactures. There is a balance of gold remaining in this country, as shown between the officially-recorded imports and exports for the fifteen years ending with 1870, of about £118,000,000.

Of the total mercantile marine of the world,

—some 15,500,000 tons—Great Britain possesses about one-half; for by the latest official returns there are owned in the United Kingdom 7,200,000 tons of merchant shipping, and, estimating this at £12 per ton, it would give us a capital of over £86,000,000 as the aggregate value of our shipping. The amount of capital invested in ships and cargo, and the large number of persons directly and indirectly employed therein, whether occupied in the business of the carrying trade, or following pursuits dependent upon shipping, give to the shipping interest an importance not shared by other pursuits. The value of the ships and cargoes that annually arrive at and leave our ports cannot be less than £600,000,000.

In estimating the carrying trade of the world, due regard must be had to the difference which the increase of steam vessels has effected in the speed of voyages, and thereby shortening, as it were, previous distances.

Our steam tonnage has doubled even since 1860.

If England expects to manufacture for the rest of the world, she must perforce bring her customers as near to her as possible. If she is to continue to supply population at the rate of 250,000 a year, to colonise distant lands, she must render the passage of the emigrants thither speedy, economical, and comfortable.

The steam shipping employed in our coasting and foreign trade, has increased from 104,680 tons register in 1850, to 1,000,000 tons in 1870. When we now find that upwards of 18,000,000 tons of steam shipping is employed yearly in our trade, the inference is

plain that, steam vessels are superseding, to a great extent, the slower sailing craft. The aggregate tonnage which entered and cleared at our ports in 1871, was 35,500,000 tons.

The increase of railway facilities has also been a great aid to the extension of Commerce. In the United Kingdom we have more than doubled the mileage of our railway lines in twenty years. In 1850 we had about 6,600 miles of railway open in the Kingdom, the traffic receipts on which were under £13,250,000; last year (1871) we had upwards of 15,000 miles of railway lines, and the traffic receipts were £40,000,000 sterling. But it is in North and South America, in India and Australia that the railways, established since that period, have most largely helped on traffic and commerce.

In India there are now about 5,200 miles of railway open, which have been made at an expense of £88,000,000.

The rapidity of the improvements in Science, and their application to our material wants, can be best appreciated by an occasional comparison with former times. It was in 1671, on the second reading of a bill in the House of Commons for building a bridge over the Thames at Putney, after a number of members had delivered speeches in ridicule of the idea, that Sir H. Herbert, just before the House divided, rose and said, "I honestly confess myself an enemy to mad, visionary projects; and I may be permitted to say, that in the late King's reign, several of these thoughtless inventions were thrust upon the House, but were most properly rejected. If a man, Sir, were to come to the bar of the House, and tell us that he proposed to

convey us regularly to Edinburgh, in coaches, in *seven* days, and bring us back in *seven* more, should we not vote him to Bedlam? Surely we should, if we did him justice; or, if another, that he would *sail to the East Indies in six months*, should we not punish him for practising on our credulity? Assuredly, if we served him rightly."

If we jump over a century and a half after these words were spoken, when railroads and ocean steam communication were beginning to astonish the world, we shall still find that there were many alarmed at the projects then on foot. The *Quarterly Review* for March, 1835, ridiculed the proposal of a railroad to Woolwich with steam coaches to carry passengers, at the rate of *eighteen or twenty miles per hour*. "We should as soon expect," says the Reviewer, "the people of Woolwich to suffer themselves to be fired off upon one of Congreve's rockets, as trust themselves to such a machine going at such a rate." We all know that a speed of *fifty miles per hour* is now easily attained!

It has been one of the great functions of railways and steam boats, everywhere, to evoke branches of traffic which no one ever dreamt of until they made their appearance, and to draw on localities, supposed beyond their reach, for commodities, hitherto deemed immoveable, by reason of the cost of transport.

Cheap telegraphic communication and cheap postage have also been great aids to commercial progress.

Another incentive to progress arose from the several great International Exhibitions, originating with that of 1851. New products have there been brought forward; new manufactures originated; com-

petition stimulated, and inquiry and investigation set on foot. Our factories have largely increased. In 1855 the textile factories of the United Kingdom were under 5,000, working 33,000,000 spindles and 370,000 power looms, and employing 600,000 operatives. In 1870 they had increased to 6,708, employing 45,235,000 spindles and 584,000 power looms, and giving employment to nearly 1,000,000 persons.

England has already done her best to clothe the world. Other nations are doing their best to serve us in return, by supplying cheaply and abundantly the raw materials we require for our numerous and extensive manufactures.

All the nations of the earth are now enrolled under one banner, on which is emblazoned the words "Utility, Art and Skill."

But it is not alone the textile factories; our soap and candle works, our paper-mills, our tanneries, our oil-presses and our miscellaneous chemical works require a large amount of raw material, for which new supplies are being continually sought.

Extended scientific agriculture at home and abroad, improved machinery, chemical discoveries, and cheaper and improved means of transport, all help on these supplies, and a freer interchange of products, by the commercial treaties entered into with various countries, has removed many obstacles which formerly stood in the way of trade.

To develope the staples of Commerce, and to apply them for the purposes of utility, Science in all branches comes promptly and effectively into action, practically to assist in promoting the happiness of mankind.

Astronomy and Magnetism lend their aid in securing the transmission of the various productions of the earth from one part of the world to another; and no sooner are vegetable and animal materials landed on our shores, than Chemistry, Electricity, Pneumatics, Hydraulics and Mechanics, are put into active operation to develope new qualities, to bleach or to dye, to spin or to weave, to mould or to measure, to cleanse and combine, to strengthen and appropriate, these various articles, which the skill and ingenuity of man applies in the most suitable manner for the promotion of his convenience and comfort.

"Science not only gives man control over the physical elements, and thus tends to emancipate him from the curse of brute labour, but also serves to widen the domain of his intellectual activities and enlarge the sphere of his moral sympathies."*

The difference which results from the advance of Commerce aided by Science, and that without it, has been well compared to the progress of the man who sees clear, and the blind man who gropes along in the dark.

The direct dependence of many important branches of industry upon chemical manufactures cannot be questioned. It would be quite impossible to enumerate a tithe of the benefits which Science has rendered to Commerce and Manufactures. Let me cite a few of the improvements which Chemistry has effected. Foremost among these may be named the magnificent series of coal tar dyes, the manufacture of the stearic acid candle,

* Professor Harvey, Secretary of the Smithsonian Institution.

the scouring of wool and woollen goods, the recovery of the fatty matters from refuse soapsuds, the preparation and employment of indigo and artificial ultramarine in calico printing, the steeping and rotting of flax straw, the bleaching of rags, and the manufacture of paper from barks, grasses, wood, and other substances.

We may almost now remove the word impossible from our dictionaries, for what is incomprehensible to-day may be thoroughly known to science to-morrow.

A prominent feature of our age in connection with science is almost unlimited faith in science as a wonder-worker, and along with this the cherished conviction that every discovery and invention admits of a practical application to the welfare of man. To all is now applied the utilitarian test.

" Is a new vegetable product brought to this country from abroad, or a new chemical compound discovered, or a novel physical phenomena recorded, the question is immediately asked, What is it good for? Is food or drink to be got out of it? Will it make hats or shoes or cover umbrellas? Will it kill or heal? Will it drive a steam engine or make a mill go? And truly this *cui bono* question has of late been so often satisfactorily answered, that we cannot wonder that the public should persist in putting it somewhat eagerly to every discoverer and inventor, and should believe that if a substance has one valuable application it will prove if further investigated, to have a thousand."*

Take as instances the varied uses of the elastic gums and of the coal tar products.

* "Edinburgh Review."

Chemistry has long come down from her atomic altitudes and electric affinities, and now scours and dyes, brews, bakes and cooks, and compounds drugs and manures with contented composure. Electricity leaves her thunderbolt in the sky, and, like Mercury dismissed from Olympus, acts as letter-carrier and message boy. Even the mysterious magnetism which once seemed, like a living principle, to quiver in the compass-needle, is unclothed of mystery, and set to drive turning-lathes. The public perceives all this, and has unlimited faith in man's power to conquer nature.*

* Mr. Piper, the Honorary Secretary of the Institution, in a paper read after mine (December 7th), said :—

"In 1805 Science had done much for Commerce, but perhaps no period of the world's history so abounds with marvels of Science enlisted on behalf of Commerce as the period that has elapsed since then.

"Witness steam vessels, railroads, telegraphs, and all their adjuncts and varieties! Witness the wondrous manner in which agriculture has become indebted to Science for its numerous and valuable appliances.

"The winds no longer indefinitely detain the argosies of our merchant princes; in spite of wind or tide they reach their destination. And not only in this does Science take the elements of fire and water and bid them in their strife do her behests, but she lays her road with mathematical precision in iron lines, and yokes to her car the mighty loads of commercial enterprise, and conveys them through the land with the speed of the swiftest bird; and that, not as a curious philosophical experiment, but as a matter of daily business, on which as certain trust may be placed as on any of the regular phenomena of the material world.

"Franklin's point coaxed the threatening lightning from the cloud, and took it quietly to earth. Now the very principle itself is seized and enlisted in the service of Commerce,

Of all the great powers of the world, there is, perhaps, no other which, from its position, circumscribed space, peculiar climate, and large population, is so dependent for many of its daily wants, most of its luxuries, and all its commerce, upon distant quarters of the globe as Great Britain. Almost every other nation possesses some compensating balance of climate, or contiguity to a neighbouring kingdom from whence it can be supplied with those essential articles of which it stands most in need, and can carry on an interchange of commodities, unobstructed by the elements. England, however, has to depend upon her ships to bridge the waters which surround her, and to obtain the products of more favoured climes, which the necessities of her population and the demands of their arts and manufactures incessantly call for.

Without Colonies and without Commerce she would sink to the condition of a petty fourth-rate State in the scale of nations, instead of holding that proud and honourable position which she has for so many years maintained.

and thus the poet's fiction becomes a reality and bids us annihilate both time and space, and 'put a girdle round about the earth in forty minutes.'

"The monsters of the northern deep furnished a languid flame to guide us through the night; now Science takes the black coal from the bowels of the earth, distils a light so brilliant that it is as if night were turned into day, and when it casts aside the refuse and the waste, Science comes again and takes it in hand, and extracts from the rejected mass dyes that will compare with Tyre's richest hues.

"Such instances might be almost indefinitely multiplied, and what has been done is but the foreshadowing of what may yet be to come."

The characteristic of an Englishman is plodding industry and indomitable perseverance. It is mainly these qualities that have compassed those improvements which have made us hitherto the purveyors of all the solid and useful articles to other nations. Our cotton and linen manufactures, our carpetings and woollen goods, our machinery, our hardware and cutlery are known and appreciated in the market in all parts of the globe.

Let us take the opinion of a Frenchman—Ledru Rollin :—

"Who can deny," he says, "that England, in a commercial and manufacturing point of view, has become the first nation in the world, and the chief moving power, the universal agent, the sovereign people of credit, circulation, and commerce? To overwhelm any audacious comparisons England has only to exhibit its fleets, its manufactories, its iron foundries, its markets, its harbours, its arsenals, its girdle of colonies and fortresses encircling the globe—comprising an empire larger than ever obeyed the laws of Rome. In its spacious docks the riches of every nation of the world are arranged in perfect order, in gigantic magazines, constituting of themselves entire cities. Never has a people in the material world developed its industry on such a scale of immeasurable grandeur. The pen cannot describe the animation of its labours, the activity of its commercial and manufacturing cities, the extent of its rural industry. Figures alone can convey an idea of its immensity."

Let me cite another opinion—that of an American, Senator Seward. In a speech in the United States

Senate made twenty years ago, he paid this compliment to our flag and our commerce :—

"Whatever nation shall put Commerce into full employment, and shall conduct it steadily with adequate expansion, will become necessarily the greatest of existing States ; greater than any that has ever existed. Sir, you will claim that responsibility and that high destiny for your own country. Are you so sure that by assuming the one she will gain the other? They imply nothing less than universal commerce and the supremacy of the seas. We are second to England, indeed, but, nevertheless, how far are we not behind her in commerce and in extent of empire? I pray to know where you will go that you will not meet the flag of England fixed, planted, rooted into the very earth? If you go northward, it waves over half this continent of North America, which we call our own. If you go southward, it greets you on the Bermudas, the Bahamas and the Carribbee Islands. On the Falkland Islands it guards the Straits of Magellan; on the South Shetland Island it watches the passage round the Horn; and at Adelaide Island it warns you that you have reached the Antarctic Circle. When you ascend along the south western coast of America, it is seen at Gallipagos, overlooking the Isthmus of Panama; and having saluted it there and at Vancouver, you only take leave of it in the far North-west, when you are entering the Arctic Ocean. If you visit Africa you find the same victorious cross guarding the coast of Gambia and Sierra Leone, and St. Helena. It watches you at Cape Town, as you pass into the Indian Ocean;

while on the northern passage to that vast sea it demands your recognition from Gibraltar as you enter the Mediterranean; from Malta when you pass through the Sicilian Straits. On the Ionian Islands it waves in protection of Turkey; and at Aden it guards the passage from the Red Sea into the Indian Ocean. Wherever Western commerce has gained an entrance to the continent of Asia, there that flag is seen waving over subjugated millions—at Bombay, at Ceylon, at Singapore, at Calcutta, at Lahore, and at Hong Kong; while Australia, and nearly all the Islands of Polynesia acknowledge its protection.

"Sir, I need not tell you that wherever that flag waves, it is supported and cheered by the martial airs of England. But I care not for that. The sword is not the most winning messenger that can be sent abroad; and Commerce, like power, upheld by armies and navies, may in time be found to cost too much. But what is to be regarded with more concern is, that England employs the steam-engine even more vigorously and more universally than her military force. Steam vessels punctually departing and arriving between every one of her various possessions and her island seat of power, bring in the raw material for every manufacture, and supplies for every want. The steam-engine plies incessantly there, day and night, converting these materials into fabrics of every variety, for the use of man. And again, the steam-engine, for ever and without rest, moves over the face of the deep, not only distributing these fabrics to every part of the globe, but disseminating also the

VALUE OF THE FOOD IMPORTS IN 1870

Arrowroot	£33,063
Cocoa	371,997
Coffee	4,942,769
Chicory	41,923
Corn, Grain, and Meal	34,169,644
Fruit of all kinds—dry and raw	3,065,065
Hops	428,525
Liquorice, Juice and Paste	68,603
Onions	390,830
Potatoes	245,306
Rice	2,310,888
Sago	218,400
Spices	852,074
Spirits	3,218,387
Sugar and Molasses	17,597,657
Tea	10,097,619
Tobacco	2,169,053
Turmeric	44,639
Wines	4,817,294
Yeast, Dried	286,097
	£85,369,833

VALUE OF VEGETABLE PRODUCTS FOR MANUFACTURES, &C. IMPORTED IN 1870.

Ashes, Pearl	£148,238
Argol	36,165
Barks, Tanning and Cinchona	384,449
Yarn of Hemp, &c	173,991
Caoutchouc and Manufactures of	1,636,828
Camphor	59,792
Candles, Stearine	285,333
Coir of all kinds	215,850
Carried forward	£2,940,646

Brought forward	£2,940,646
Cork Bark and Corks	318,119
Cotton and Cotton Manufactures...........	54,759,407
Cutch and Gambier...........	468,388
Flax	5,979,127
Furniture and Cabinet Ware.................	91,871
Gums..	662,195
Gutta Percha	496,951
Hemp...	2,063,377
Jute...	2,388,474
Indigo...	2,721,208
Linen Yarn and Manufactures	173,573
Madder, Munjeet and Garancine	707,193
Oil Nuts and Kernels...........................	325,542
Oils..	4,043,111
Oil of Turpentine	134,027
Oil Seed Cake	1,417,100
Opium...	484,138
Orchil..	112,693
Paper..	713,046
Pitch and Tar......................................	174,651
Platting	31,569
Rags, &c., for Paper............................	1,201,574
Rhubarb...	62,617
Rosin...	873,918
Safflower..	168,536
Seeds—	
Oil, unenumerated	161,447
Cotton	1,091,132
Rape	1,737,227
Flax and Linseed...............................	4,016,016
Agricultural	1,142,605
Sumach	228,431
Turpentine..	30,272
Wood of all kinds	13,665,063
	£105,085,244

We have heard lately much discussion about our intemperate habits, but as I have only to deal with Commerce—properly so called—and not with home trade, I cannot go into comparative data as to the quantity of beer and home-made spirits drank. Our wine imports have risen in the last twenty years from 9,000,000 to 15,000,000 gallons, and the foreign spirits from 8,000,000 to 16,000,000 gallons. But it is pleasing to find that "the cup which cheers but not inebriates" has made far greater progress in the same time, for our imports of coffee have risen from 51,000,000 lbs. to 192,000,000 lbs.; of cocoa, from 4,500,000 lbs. to 17,500,000 lbs., whilst tea has risen from 50,500,000 lbs. to 171,000,000 lbs., and the great bulk of these imports is consumed here.

It was thought at one time that the Chinese would be unable to supply any extraordinary demand made upon them for this dried leaf when the duty was reduced; but it is satisfactory to notice that the culture is extending over the world. Tea is now produced largely in Japan and in British India, and has been successfully introduced into Brazil, California, and Australia.

The same important progress is shown in the increased consumption of all the other great staple products. Sugar has increased in consumption from 6,500,000 cwts. to 14,000,000 cwts.; spices from 11,000,000 lbs. to 28,250,000 lbs.; rice from 750,000 cwts. to 4,500,000 cwts.; dried fruits have also nearly doubled, whilst the imports of tobacco have risen from 36,750,000 lbs. to 73,000,000 lbs.

There is a class of commercial products which is of great importance to us in many ways—the gums and

resins, so essentially useful in the arts and manufactures, and in medicine. Although by the chemical manufacture of dextrine, we have found a gum substitute in our calico print works, and for our adhesive stamps and labels, yet we cannot do without large quantities of gum arabic, for we received in 1871, 74,711 cwts. Kowrie resin, animi and copal are a necessity to the varnish maker; and so wide is this one field of investigation, that it afforded me the subject for an evening's lecture many years ago at the Society of Arts.* I may, however, point out to you the great commercial progress made in the elastic gums:—

IMPORTS OF ELASTIC GUMS.

	1850.	1870.
Caoutchouc	7,616	152,118 cwts.
Gutta Percha	11,130	33,517 „

VALUE OF THE IMPORTS IN 1870.

Caoutchouc and Manufactures of	£1,637,828
Gutta Percha	496,950

In 1871 the imports of caoutchouc were even larger, reaching to 161,588 cwts. There are 33 india rubber and gutta percha manufacturers in the kingdom, employing about 6,000 hands, and it is difficult to say what india rubber does not enter into now—from waterproof garments to submarine cables. Instead of the supply of the elastic gums being exhausted, an impetus has been given, by the increased demand and price, to the search for them, and we now get supplies from Africa, Australia and India, as well as from South and Central America.

* "Journal of the Society of Arts," vol. iv, p. 13.

I now pass on to another branch of raw materials, those required for our textile manufactures, and how important these have become a few figures will show.

At the close of the last century (in 1790) we received the following foreign supplies :—

Hemp	592,306 cwts.
Flax	257,222 „
Cotton	27,300 „

In the year 1816 the imports of hemp and flax had decreased considerably, but the cotton supplies had trebled. How insignificant, however, are these figures, when compared with the results of this year (1871), when the hemp received was over 1,320,000 cwts., the flax nearly 2,600,000 cwts., and the cotton nearly 16,000,000 cwts., besides jute and other fibres to the amount of 3,500,000 cwts. more.

Some idea of the magnitude of the interests involved in the textile industries of the United Kingdom may be gathered from the fact I have already stated, that the number of persons actually employed in the mills, factories and works, now falls little short of 1,000,000, and the larger number are females; the cotton factories employ one-half of the whole operatives engaged in in textile industries.

In 1850 the value of our cotton manufactures and yarn exported was £28,250,000; in 1860 it was £50,000,000, and this year (1871), it was more than £72,500,000, and this, be it remembered, is exclusive of our home consumption, the value of which is nearly as much more. There is also a large proportion of cotton used up in the mixed fabrics, woollens, haberdashery, millinery, silk, apparel and slops exported.

The following is an aggregate statement of the quantity and value of the principal vegetable fibres we now import, taking the figures of 1870 :—

	cwts.	£
Cotton	11,931,979	51,000,000
Flax	2,373,528	6,000,000
Hemp	1,108,839	2,000,000
Jute	2,403,550	2,250,000
China Grass	951	4,000
Paper Materials	2,207,240	750,000
	20,026,087	£62,004,000

A remarkable instance of the rapid progress that may be made in a manufacture, is afforded in the instance of what is known as jute, or Indian hemp, a fibrous substance, obtained from two plants of the genus *Corchorus*, exclusively cultivated in Bengal. It was at first chiefly used for spinning into rope, and for making the coarse packing material known as gunny bagging, which is so largely used in America for covering cotton bales. Now, Dundee has become the chief seat of the jute manufacturing industry. It is there woven into common carpets; it is mixed with cotton warps of cheap broadcloths, and also with silk, and from its lustre, can scarcely be detected.

In 1853 the imports were only 275,000 cwts., while this year (1871), we received nearly 3,454,386 cwts., of the value of £4,103,736, and exported jute manufactures valued at more than £1,000,000.

The silky-looking fibre, called China grass, is not a grass at all, but is from a species of nettle, called Rheea in most of the Eastern countries, the produce of *Boeh-*

meria nivea. Probably the name was applied by the Chinese, like rice-paper, for the purpose of obscurity and deluding other nations. The plant is, properly speaking, a frutescent or suffruticose shrub—that is, the stem at first is soft and herbaceous, and afterwards becomes half woody, half herbaceous.

Certain practical difficulties in peeling off the outer, and obtaining the inner bark, which yields the fibre, have hitherto prevented it from being, to any large extent, usefully and profitably employed.

The Indian Government have long offered a reward of £5,000 for a machine capable of cleaning the stems at a cost of £15 per ton, and admitting of selling the fibre in the English market at £50 per ton; from samples I have lately seen, and the attention given to the subject here and on the Continent, I believe the problem will soon be solved.

There are a large number of miscellaneous fibres imported for various purposes, but to specify all of these would take up too much time. I may, however, enumerate one or two of importance. Cocoa-nut coir; New Zealand flax; Matting, of which great quantities come in from China and elsewhere; Piassaba, a palm fibre, from Brazil, and Mexican grass, so called, but really from an Agave, for brushmaking.

I must not pass over the materials imported for our paper mills. The demand for paper for printing has increased so rapidly that the waste rags collected are quite insufficient, and, for some years past, new substances have had to be sought for. That which has been obtained in the largest quantity, is a wiry kind of grass growing wild on the Spanish and African coasts

of the Mediterranean, known as esparto. It was long before our paper makers could be got to use it; but now they have found it such an effective substitute, that the price is rising, and the imports have become enormous, more than 100,000 tons a year.

If we look next at our foreign imports of vegetable oils, and oil seeds, we find how great an impetus has been given to trade by new supplies; palm oil, cocoa-nut oil, olive oil, and seed oils; flax seed, rape seed, and cotton seed,—are all largely imported, and the aggregate value of these, added to the oil cakes from them, exceeds £10,000,000 sterling.

The palms are exceedingly prolific in oils and fats, especially the oil palm of Africa, and the cocoa-nut palm of Ceylon and the Tropics, which furnish the bulk of the solid vegetable oils imported for soap and candle making. Carnauba wax, from a Brazil palm, is an extensive article of local commerce, and a small quantity reaches this country.

In the year 1808, 200 tons of palm oil were received from Africa; in 1827 the quantity had increased to 4,700 tons. Some few years later it had risen to 14,000 tons. What do we find it now?—more than 50,000 tons. Palm oil has become one of the most important articles of commerce from the West Coast of Africa, especially to this country, although we are not the only importers. The collection and shipment of palm oil has done more than anything else to suppress the slave trade.

The oil as manufactured for home consumption in Africa, is slightly different from that prepared for shipment. It is darker coloured, and is obtained by

beating, pressing, and boiling the fruit (sarcocarp) of the palm.

Palm-nut oil is obtained from the seed or kernel by roasting, beating, and boiling it. Formerly these kernels were thrown away, but now they form an enormous trade.

Another important aid to Commerce has been the great attention given of late years to the utilisation of residues from manufactures, and substances formerly wasted. It is satisfactory to me to look back and find that suggestions which I threw out ten and twenty years ago in various papers and works "On the Utilisation of Waste Substances," have resulted in large profits to many, and originated, as it were, new manufactures. Let me cite but a few instances.

The preparation of flax wool from the refuse of the flax spinners has been profitably applied to the manufacture of cloths and blankets, &c.

There is a waste of nearly two ounces of cotton to the pound in spinning, and formerly this residue was of little or no value. Now, however, it is saved, and applied to important industrial purposes. Some 60,000 tons of cotton waste, 20,000 tons of flax waste, and the same quantity from rope and canvas, gives a large total to be utilised.

I have placed before you specimens from a large Lancashire mill of this cotton waste spinning. First, the cotton waste as obtained, called "mixing," then its various stages of process—lap, refuse, carding, and slubbing, till it is made into yarn. The article is used in this state, after being sized, for backing of carpets. When bleached it is made into counterpanes, candle-

wicks, &c., and used for other manufacturing purposes.

Nearly three-fourths of the cotton crop by weight consists of seed, and there cannot, therefore, be less in all the cotton growing countries than 2,500,000 tons of seed available. Formerly it accumulated in offensive and noxious piles about the cotton gins, or was only used for manure, now the oil made from it for burning and eating, and the oilcake for cattle, are greatly in demand. The residue, after refining, is distilled, and with care produces a hard grease or stearine fit for soap making, while the foots or tarry substance forms a useful paint ingredient.

A curious application of a waste product is the utilisation of the leaflets of pine trees, which are converted on the Continent into what is called forest wool, used for stuffing upholstery. Vegetable wadding and hygienic flannel are made of it, said to be useful in rheumatism and skin diseases. Cloth is woven from it, and articles of dress, such as vests, hose, shirts, chest preservers, and coverlets. An ethereal oil is also obtained. The membraneous substance and refuse are compressed into blocks, and used as fuel. From the resinous matter they contain sufficient gas is produced for illuminating the factory.

Here are some few other examples of the numberless applications of substances, formerly waste, or at least of very limited use.

Silk cotton, from the seed capsules of the *Bombax*, which is now used in Holland under the name of "kapok" for filling beds and pillows.

The Spanish cane, or "rattan," as it is called in

commerce, is the curious creeping stem of some palms, *Calamus Rotang*, &c., common in the eastern forests, and which attain to a great length; some were shown at the last Paris Exhibition, from the Philippines, which were more than 250 feet long.

Besides about 3,500,000 canes and sticks, worth £27,000, we import annually nearly 21,000,000 of these rattans, which are worth 4*s.* per 100 or bundle, and £40,000 in the aggregate. They are used chiefly for caning chair bottoms, and replacing osiers in basket work. On the Continent their use has attained within the last four or five years very large dimensions. One firm at Antwerp which gives employment to 2,000 people, imports 3,500 tons of rattans annually, and by improved machinery has largely extended their industrial applications. A chair on the Continent may be caned with the split silicious bark for 6*d.* or 7*d.*, whilst here we pay about 1*s.*, and for seats to chairs they have almost entirely superseded straw and rushes, and osiers in basket work. The cane dyed is now used as a general substitute for whalebone and steel in the ribs of cheap parasols and umbrellas, a set of ribs for a parasol costing only ½*d.* or 1*d.*, and for an umbrella 8½*d.* instead of 2*s.* 6*d.* or 3*s.* for whalebone. But it is also used largely for matting, and the waste for filling common sleeping mattresses, which are sold wholesale as low as from 4*d.* to 8*d.* each, whilst it also replaces hay and straw for packing purposes.

Time would fail me to enumerate a tithe of such applications, showing the profitable utilisation of waste substances, a topic which has served me for the theme of many a commercial discourse.

For constructive purposes we must have timber and wood, and but for the enormous supplies we draw from the North of Europe and British North America, our builders and engineers would be put to sad straits, for although iron enters largely into building operations now, we cannot do without timber. Wood is necessary for the ship builder, the house builder, the cabinet maker, the turner, and others. Exclusive of our home supplies of timber we pay more than £12,000,000 for foreign woods, independent of the dye woods. Within the last twenty years many new ship building woods, such as the greenheart of British Guiana, and the blue-gum of Australia, have been adopted and recognised at Lloyd's.

In 1801 we only imported 161,869 loads of foreign timber. In 1840 the imports were 807,818 loads. In 1871 the import of wood exceeded 4,500,000 loads, the largest quantity ever yet brought into this country in one year; and the aggregate declared value of woods of all kinds and forest products received from abroad is over £15,500,000 sterling. Largely as iron is now used for constructive purposes, far from superseding timber, it has led to additional uses for it, and given a great impetus to Commerce. Although great changes do from time to time take place, yet they are after all rather beneficial than injurious. Machinery has displaced manual labour in spinning and weaving; but it has greatly extended employment in the manufacturing districts; and although railways have done away with the old stage coaches, and many other carriers and road conveyances, they have increased rather than diminished the demand for horses.

In connection with our timber supplies it may incidentally be mentioned that at least four-fifths of the imports are supplied by the single order of coniferous trees; and one-fifth of all the imports comes to the Port of London.

Many new industries have been originated of late years from forest products, such as the preparation of wood pulp, the crushing of bamboos, and the collection of fibrous barks, for paper making; the manufacture of fancy walking-sticks and the economic uses of leaves. Forest products also yield to commerce—tar, rosin and turpentine, pearl and pot ashes, cork bark and many other articles.

Some of the fancy cabinet woods are very beautiful and much sought after, and the fine collection of these shown by our colonies and foreign countries at the various International Exhibitions have brought many new kinds into Commerce.

Let us pass now to another class of products, which are essentially necessary to the progress of our manufactures, and for which we pay nearly £7,000,000 annually. These are the dyewoods, colouring and tanning substances, the bulk of which are obtained from the vegetable kingdom.

The dyestuffs are furnished by various parts of plants. The bulky ones are from woods, of which South America and the West Indies furnish us the Brazil and log woods, fustic and quercitron, Nicaragua and green ebony; Africa, barwood, camwood and Guinea wood; and India, the sappan and red sanders woods.

Then we have many seeds and fruits, as, for instance,

what are known as yellow or Persian berries, myrobalans from India, the wrinkled dividivi pods, and the acorn cups of an oak from Turkey.

Roots furnish a very large portion, as in the madder and munjeet of commerce, and turmeric; whilst inspissated extracts, like indigo, gambier, cutch, and gamboge, make up the remainder.

To particularise and dwell upon these would be impossible; but one remark may be made, and that is, that the discovery of the brilliant coal tar dyes has materially interfered with the commerce of many foreign dye substances, and the fluctuations in some of them have been considerable.

Another resulting benefit of Science is the economy of freight, which has resulted from the concentration of many of these bulky articles. Thus, although we import 100,000 cwts. of madder and madder roots less than we did in 1855, we receive about 20,000 cwts. more of the concentrated powder—garancine, which is prepared from it. In chemical manufactories on the Continent the concentrated colouring matter of the dyewoods is now specially prepared and sent here for the use of the dyer; and extracts of bark are also sent home from North America to the extent of 40,000 cwts. The progress of our various manufactures is plainly shown in the great increase of tanning barks and of valonia, which have doubled since 1855; of gambier and cutch, which have also doubled, and of indigo, which has increased by 20,000 cwts.

TRAVERS' COURSE.

LECTURE II.

MINERAL PRODUCTS AND ANIMAL SUBSTANCES ENTERING INTO COMMERCE.*

In my former lecture I gave you a slight sketch of the enormous progress our Commerce has made, and as a consequent result the great advance in our factories. I showed you also the indebtedness and Obligations of Commerce to Science, and I passed under review the principal raw materials which we obtain from the vegetable kingdom, and the progressive novel applications that had been made of them.

In these days no apology for scientific experiment is required, for although the primary object of Science is the discovery of truth, it is now universally admitted that the contributions applied to the arts of life are among the most valued means by which our civilisation is advanced. In new countries the problem of the utilisation of their resources opens the widest opportunities for the adaptations of Science to practica requirements. The supply of animal food affords an example in illustration of this general assertion. Countries like the republics of the River Plate and the colonies of Australia have inexhaustible means of supply, while in European countries flesh food is becoming yearly scarcer. Any improved method of animal food preservation, assisting its transport, would

* Delivered at the London Institution, Finsbury Circus, November 30th, 1871.

be a vast accession to their means of wealth, and to this end the facts of chemistry in relation to physiology appear as affording the proper key. The case of food supply is by no means a solitary instance; the same reasoning applies generally to the natural resources of all new and extensive countries, like those named.

As Liebig well observes:—"Science teaches us the simplest means of obtaining the greatest effect with the smallest expenditure of power, and with given means to produce a maximum of force. The unprofitable exertion of power, the waste of force in agriculture, in other branches of industry, or in social economy, is characteristic of the want of true civilisation."

"No living being is entitled to claim perfection for the arts useful to man. They are progressive in their very nature; and often when they are thought to be carried to the very highest point of excellence an unexpected discovery opens to them a new career."*

It is one of the characteristics of the present age that commercial associations of private persons, receiving from the State no assistance except a sanction for their union and employing their funds only in the ordinary modes of Commerce, have been able to execute works which scarcely any power in the State could attempt, and incidentally to give to objects not contemplated in their original enterprise an amount of assistance which no direct action of the State could give. The latter advantage has been experienced in numerous instances affecting our social comforts and our constructive arts; it has been felt with equal force

* Baron Dupin.

in our more abstract sciences. Of this, instances are afforded in the readiness with which facilities were granted by the Submarine Telegraph Company and the Anglo-American Telegraph Company to determine accurately the difference of longitude between the Observatories of Greenwich and Paris, and Greenwich and Washington.* It is most honourable to our great commercial bodies that they have practically shown so much readiness to aid in enterprises of a scientific character, that accredited men of science feel no difficulty in asking their assistance. We may congratulate the world on the growing tendency towards a closer union between Science and Commerce. The advantages to science in such instances as I have alluded to need no further explanation. The advantages to commercial bodies, though less obvious, are equally certain. It is no small matter that these associations are enabled, without any offensive intrusion, to acquire the character of patrons of science, and that the world is ready to acknowledge itself their debtor for assistance not promised in their original constitution. The exhibition of beneficial power without any prospect of immediate pecuniary advantage removes the mercenary element which might

* Two methods of making astronomical observations, first introduced into work of the kind by the United States Coast Survey, have drawn very flattering commendation from the old astronomers and masters of survey in England and Europe generally. They are that of determining the latitude with the zenith telescope, and that of determining the longitude with the aid of the telegraph. The accuracy obtained by these methods is such that they have nearly superseded all others.

seem to be engrafted in their original formation, and Commerce thus acquires dignity from its friendly union with Science.—*Professor Airy.*

As this kingdom mainly owes its industrial and manufacturing industry to its great mineral wealth, and the home products of these are generally well known, I need not dwell to any extent on our imports of minerals and metals, which are limited in comparison with those of animal and vegetable origin. I pointed out in my former lecture the value of the trade in gold and silver coin and bullion, and I shall now pass cursorily under review the several minerals and metals we receive from abroad.

It would be difficult to mention a single branch of human industry which for its present state of perfection is not more or less indebted to the use of sulphuric acid. It may almost be said to be the chemist's factotum, to so great a multitude of uses in the arts is it applied. Its cheapness, its powerful affinities, the concentrated form in which it may be obtained, and other peculiarities render it by far the most valuable agent in manufacturing operations which we possess. Under the trade name of "brimstone" we import more than 50,000 tons of sulphur from Sicily, at a price of about 7*s.* 6*d.* a cwt., but our manufacturers have found it cheaper to import iron and copper pyrites, as sulphur ores, to the extent of 450,000 tons, at a price of about £3 14*s.* per ton, the yield being 40 to 50 per cent. of sulphur. We obtain also about 76,000 tons of iron pyrites at home.

Of quicksilver we import variable quantities, and a good deal is re-exported to the Continent and India.

In 1850 and 1851 we received only a few hundred thousand pounds, this year (1871) nearly 3,000,000 lbs. were imported.

This metal, differing from all others in being semi-fluid until subjected to an intense degree of cold, 39° below zero, when it becomes solid, is extensively employed in the amalgamation of the nobler metals, in water-gilding, the making of vermilion, silvering mirrors, for barometers, thermometers, and in medicine. Quicksilver is a substance of paramount value to science. The nitrate of mercury is employed for the secretage of rabbit and hare skins, that is, for communicating to the fur of these and other quadrupeds the faculty of felting, which they do not naturally possess. Quicksilver was formerly imported into this country in sheepskins, from which the wool had been removed, of several thicknesses. It has sometimes come from China in the joints or internodes of the bamboo, about a foot long and three inches across, closed with rosin. These ready-made bottles, which held about 20 lbs., were covered with linen cloth, cemented on. Of late years it is shipped in wrought-iron flasks, weighing about 25 lbs. which are made in England. These iron bottles hold 76 lbs. of quicksilver.

The two main sources of supply of the cinnabar ores, from which quicksilver is obtained are the Almaden mines of Spain and the New Almaden mines of California. The produce of both these mines has got into the hands of very wealthy individuals, who have reduced the supply to increase the price.

Every year large additions are being made to the number of mines requiring the use of quicksilver for

their exploration, while the different manufactures in which this substance is an essential requisite are also more generally extended.

The use of ultramarine, which was at one time almost as valuable as gold dust, has been so extended and cheapened by the labours of the chemist, that its artificial manufacture must be regarded as one of the triumphs of modern science. We imported from the Continent, in 1870, upwards of 34,000 cwts., valued at £140,000. It comes principally from Holland, although Belgium and Germany supply some.

Our imports of copper ore and regulus (a term given to the crude metal separated from the ore) have been on the average about 110,000 tons for some years past, but of copper wrought and partly-wrought there has been a great increase, the imports reaching now 600,000 to 700,000 cwts. against an average of about 100,000 cwts., fifteen years ago. Of iron, wrought and unwrought, our imports are not large, scarcely 110,000 tons. Pig and sheet lead have, however, increased largely, as we now receive about 58,000 tons from abroad in place of 7,000 or 8,000 tons. Of foreign tin we import an increasing quantity, 4,000 to 5,000 tons being required to supplement the 7,000 tons obtained here. A small quantity of silver ore and about 30,000 tons of zinc in cakes or rolled, completes our indebtedness to foreign countries for products derived from the mineral kingdom.

The quantity of coal raised in the United Kingdom is now about 115,000,000 tons; we export 5,500,000 tons, and consume the remainder in our domestic hearths, our factories, work-shops, and steam

engines. The coal exported and used for house consumption may be valued at £1 the ton, but a large deduction has to be made in price for that used in the localities near which it is produced.

The use of coal gas, of petroleum oils, of paraffine and other mineral waxes has much interfered with the commerce and employment, for illuminating purposes, of whale oil, of colza oil, of tallow and beeswax.

The mineral oils now form an extensive article of commerce, especially the American petroleum, paraffine, and ozokerit. Of paraffine we imported 11,835 cwts. in 1870.

The American petroleum trade is a novel and important one. The export has risen from 1,500,000 gallons in 1861 to 141,000,000 in 1870. The home consumption is estimated to be equal to one-half of the quantity exported, making an aggregate production in the United States alone of 211,000,000 gallons annually, and the Pennsylvania oil wells seem almost inexhaustible. This enormous amount, reckoning the price at an average of 20 cents per gallon, represents a value of £8,400,000 for the year, certainly a remarkable return for a product unknown to commerce ten years ago. Canada also now produces 300,000 barrels a year of which half is exported. In the four years ending 1870, 1,000,000 gallons were used locally, and 7,000,000 gallons exported. Our supplies of petroleum oil vary; in 1863 there were 9,000,000 gallons imported, in 1870 we received under 7,000,000 gallons. But the imports of 1871 were rather larger, nearly 36,000 tuns against 27,000 tuns in 1870.

In closing this part of my subject I append for

reference tables of the value of our export and import trade in metals and mineral products.

COMPARATIVE VALUE OF BRITISH MINERAL EXPORTS IN THE YEARS 1850 AND 1870.

	1850.		1870.
Agricultural Implements	£47,368	...	£223,815
Soda (Alkali)	375,351	...	1,485,596
Arms and Ammunition	98,124	...	1,876,756
Cement	26,468	...	366,199
Coals, Culm, &c.	1,284,224	...	5,506,890
Earthenware and Porcelain ...	999,448	...	1,692,395
Glass	307,755	...	831,449
Hardware and Cutlery	2,641,432	...	4,513,034
Machinery and Steam Engines	1,042,166	...	5,286,503
Iron and Steel of all kinds ...	5,350,056	...	21,080,494
Copper and Brass..................	1,978,196	...	3,062,136
Lead, &c.	492,277	...	1,281,279
Tin and Tin Plates	1,052,893	...	3,006,054
Zinc	25,338	...	141,282
Plate, Jewellery, Watches	296,078	...	551,497
Salt....................................	224,501	...	381,127
Telegraphic Wire and Apparatus	——	...	2,522,403
	£16,641,675		£53,808,509

VALUE OF THE IMPORTS OF MINERAL PRODUCTS AND MANUFACTURES INTO THE UNITED KINGDOM IN 1869 AND 1870.

	1869.		1870.
Aluminium	£47	...	——
Arms and Ammunition............	93,970	...	£121,028
Antimony Ore, Regulus, &c. ...	37,487	...	94,962
Art, in Bronze and Marble	42,755	...	47,377
Asphalte	82,911	...	124,473
Barytes, Sulphate of..............	9,749	...	8,913
Carried forward	£266,919		£396,753

Brought forward	£266,919		£396,753
Bell Metal and Medals............	27,957	...	15,550
Borax	52,985	...	34,802
Brass Manufactures	53,402	...	38,550
Brass, Old	3,065	...	1,634
Bricks	860	...	1,022
Brimstone	388,723	...	386,660
Bronze Manufactures	41,052	...	23,037
Bronze Powder	4,146	...	5,186
Buttons of Metal	5,487	...	3,310
Candles, Paraffine	3,277	...	——
China and Porcelain Wares......	180,626	...	150,347
Cinnabar and Cobalt...............	15,971	...	26,915
Copper Ore, &c.	4,263,779	...	4,095,722
Cubic Nitre...........................	702,055	...	881,080
Emery Stone	20,634	...	34,113
Glass of various kinds	921,524	...	931,467
Gold, Leaves of	80,128	...	68,528
Hones	950	...	540
Ice.......................................	96,305	...	81,218
Iron	1,025,577	...	1,793,874
Iron, Old, &c.	88,507	...	83,212
Jewellery..............................	79,092	...	155,885
Lead Ore, and Lead of all kinds	1,872,382	...	1,244,416
Manganese Ore	236,892	...	154,059
Marble	113,197	...	159,748
Metal, Old, &c.	139,964	...	66,589
Metal, Leaf	49,241	...	42,443
Metals, Unenumerated............	24,894	...	32,191
Naphtha, Crude.....................	39,115	...	212,648
Nickel Ore, &c.	12,658	...	16,153
Ochre	8,966	...	6,652
Orsedew	3,567	...	4,775
Paraffine	28,450	...	36,804
Pencils, Slate, &c.	30,894	...	33,377
Percussion Caps.....................	3,584	...	776
Carried forward.........	£10,886,825		£10,390,036

Brought forward	£10,886,825		£10,390,036
Petroleum	442,858	...	535,272
Plaster of Paris	12,361	...	13,678
Plate, Gold and Silver, and Plated Ware	25,919	...	22,516
Platina................................	28,568	...	39,147
Plumbago	187,111	...	118,878
Pyrites................................	856,962	...	1,095,151
Quicksilver	223,722	...	284,503
Salt	26,149	...	23,820
Saltpetre	307,764	...	384,392
Silver Ore	178,398	...	299,726
Smalts and Zaffres	3,935	...	9,983
Stones, Mill, Lithographic, Pumice, &c.	68,757	...	46,070
Terra Sienna and Umber	4,674	...	2,445
Tin	699,262	...	623,639
Tin Plates, &c.......................	6,533	...	4,498
Tobacco Pipes of Clay	5,871	...	5,451
Ultramarine	130,719	...	140,143
Verdigris and Vermilion	23,937	...	27,963
Watches	199,207	...	372,420
Wire, Gilt and Plated	20,570	...	9,287
Zinc	860,339	...	814,102
Zinc Manufactures	16,250	...	17,847
	£15,216,691		£15,280,967

If animals could speak, as Æsop and other fabulists make them seem to do, they would, I think, declare man to be the most voracious animal in existence. There is scarcely any living thing that flies in the air, swims in the sea, or moves on the land, that is not made to minister to his appetite. Fish, flesh, or fowl, all comes alike to his hungry maw. But, numerous as the food substances of civilised man already are, there is no doubt the list might

be greatly extended, if people could be prevailed to taste and try, setting prejudice and custom aside. Make use of every material possible for food, remembering that there are chemical affinities and properties by which nutriment may be extracted from almost every organic substance, the greatest art being in proper cooking; of this the French had ample proof during the siege of Paris.

We consume a large quantity of fish, both fresh and cured. Besides our coast fishery for mackerel, herring, pilchard, &c., the Royal Commissioners report that there are nearly 1,000 sail of trawlers employed in and about the North Sea; 5,000 seamen are engaged in them, and about 300 tons of fish daily sent to market, valued at £1,500 to £2,000. The cured or salted fish we import now reaches about 31,000 tons annually.

With respect to supplies of animals and animal food from abroad, protective duties long stood in the way of Commerce. The importation of cattle and sheep was prohibited until 1842. Bacon was only admitted duty free in March, 1845, and foreign cured hams in June, 1853. The duty on butter and cheese was reduced in 1846 and in 1853, and abolished altogether in March, 1866. The duties on other raw materials of animal produce were removed in the following years:—Wool, 1844; silk and woollen manufactures and tallow reduced in 1846; oil and spermaceti in 1849; and in 1860 the customs' duties were entirely repealed on foreign butter, cheese, and eggs, on boots, shoes, and gloves, tallow, and silk manufactures.

The live stock we slaughter annually in the United Kingdom for food may be valued at £64,000,000, and the dairy produce we consume—butter, cheese, eggs, and poultry—at £25,000,000.

The imports of cattle and animal food products have very largely increased in the last thirteen years.

The average imports for the three years ending 1858-60, and 1868-70, were as follows, taking round numbers:—

	1858-60.	1868-70.
Cattle and Sheep.. head of	345,000 ...	760,000
Beef ....cwts.	217,000 ...	230,000
Bacon .... „	210,000 ...	618,000
Pork .... „	142,000 ...	200,000
Lard .... „	137,000 ...	237,000
Butter .... „	551,000 ...	1,172,000
Cheese .... „	451,000 ...	964,000
Eggs.................number	150,500,000 ...	419,000,000
Fish ....cwts.	301,000 ...	625,000

VALUE OF IMPORTS OF ANIMAL FOOD IN 1870.

Animals, Living	£4,371,507
Bacon and Hams	1,769,241
Beef	461,521
Butter	6,793,877
Cheese	3,274,331
Eggs	1,102,080
Fish	768,387
Lard	727,192
Meat, Salted and Fresh	96,042
Pork	799,508
Poultry, Game and Rabbits	158,482
	£20,322,168

As the butter produced in the kingdom is quite insufficient for our consumption, we import 60,000 tons from abroad. The home consumption cannot be

less than 1[illegible]0,000 tons, allowing 16 lbs. yearly for each individual, of two-thirds of the whole population. Taking an average price of 1*s.* 3*d.* per pound for fresh and salt, this gives a total of £17,600,000 paid for butter alone.

VALUE OF EXPORTS OF ANIMAL SUBSTANCES AND MANUFACTURES OF BRITISH PRODUCE, 1870.

Bacon and Hams	£340,713
Beef and Pork	121,228
Candles	115,473
Cheese	110,336
Herrings	743,721
Other Fish	193,461
Horses	255,215
Boots and Shoes	1,143,192
Leather	299,559
Saddlery and Harness	326,711
Silk Yarn	1,154,046
Silk Manufactures	1,447,657
Wool	575,583
Woollen Yarn	5,175,757
Woollen Manufactures	21,650,460
	£33,053,112

Besides re-exports of Foreign Produce.

IMPORTS OF PROVISIONS.

		1850.		1870.
Bacon and Hams	cwts.	352,461	...	579,199
Beef	„	135,414	...	240,194
Pork	„	211,254	...	220,533
Butter	„	330,579	...	1,159,481
Meat, not otherwise described	„	—	...	114,936
Cheese	„	347,803	...	1,041,281
Eggs	number	105,689,060	...	430,842,240
Fish	cwts.	87,320	...	582,380
Lard	„	229,614	...	217,696

EXPORTS OF BRITISH PRODUCE AND MANUFACTURES, 1870.

QUANTITIES.

Bacon and Hams	cwts.	74,498
Beef and Pork	„	42,013
Candles	lbs.	3,349,983
Cheese	cwts.	25,208
Herrings	barrels	602,617
Other Fish	value	£193,461
Horses	number	7,202
Leather, Boots and Shoes	pairs	4,447,836
Leather	lbs.	1,392,896

Of another dairy article—cheese—we import about the same quantity as of butter; and, calculating that the same proportion of the population use but half an ounce a day, or 12 lbs. per year, this gives a total consumption of 112,500 tons.

We do not receive any very large supply of live animals from abroad for food, and even these fluctuate annually, according as the cattle disease prevails and sanitary regulations are enforced. About 200,000 head of cattle, and 600,000 or 700,000 sheep are imported yearly from the Continent; but a good deal of dead meat is also received. About 117,000 cwts. of fresh, salted, or preserved meat was imported in 1870, and as much as 300,000 cwts. in 1871.

The great consumption of butchers' meat in the United Kingdom has become an important consideration to the housekeeper, and especially in view of a future adequate supply at more moderate prices, the graziers being unable to meet the increasing demand The large consumption arises from two causes, which in all probability will continue to operate, namely—the

increase of population at the rate of 1,200 or 1,400 a day, and the general improvement in the condition of the operative classes, consequent upon the enormous extension of our Commerce and Manufactures, and the abundant employment thus created, and by railway and other national works. The weight and quality of the animals bred are widely different from what they were. One hundred and fifty years ago, the average weight of a beast at Smithfield Market was not above 350 lbs.; now it exceeds 800 lbs.

Large numbers of sheep are used by the meat-preserving and boiling-down establishments, estimated at 200,000 in the single small colony of South Australia in 1870. In New South Wales there were, last year, no less than 48 boiling-down establishments, as they are termed, for converting beef and mutton into tallow. The price of cattle has been commonly quoted at "boiling rates;" in other words, fat cattle would fetch no more from the butchers than could be realised from their hides, horns, tallow, &c., for exportation. Under the old and slovenly system of sending cattle to the melting-pot, it is certain that from one-fourth to one-half of what ought to have been profitably turned to account was wasted. The value of cattle and sheep must in future be measured in the Colonies, not by the local demand for butchers' meat, but by the price which can be obtained for the various constituents of the carcase in the markets of the world. The utilisation of this waste animal food has received a large share of attention in the last three years from various companies established to prepare animal food in different forms, whether as extract

of meat, tinned provisions, or dried and smoked meat.

The value of the meat imported here from Australia, which was in 1868 but £45,000, had increased in 1871 to nearly £700,000.

The daily papers have within the last few weeks been drawing attention very prominently to this subject, and the correspondence and discussion that have ensued, are likely to be beneficial.

The contrast between the prices we are paying here for butchers' meat, and those given in the following advertisement from a late Sydney paper, are very striking.

P. M'CARROLL.

GLORIOUS NEWS FOR THE PUBLIC.

TO CLUB HOUSES, HOTEL and BOARDING HOUSES, and the PUBLIC at large.

GREAT REDUCTION IN THE PRICE OF MEAT.

LIST OF PRICES FOR CASH ONLY.

	Per lb.		Per lb.
Hind quarter of Mutton	1¼d.	Fore quarter of Beef	1¼d.
Fore ditto ditto	1d.	Spice Beef	5d.
By the whole Sheep	1¼d.	Round of Beef, cooked	4d.
By half Sheep	1¼d.	German Sausage	4d.
Mutton Chops	2d.	Black Pudding	3d.
Rump Steaks	2½d.	Beef Sausages	1½d.
Beef Steaks	1½d.	Pork Sausages	4d.
Boiling Beef	1¼d.	Legs of Pork	4d.
Corn Beef	1d.	Loins of Pork	4½d.
Best Ribs of Roasting Beef	2d.	Whole or half Pig	4d.
Chuck Ribs	1½d.	Veal	4d.
Sirloin ditto	2½d.	Ox Tongues	2s. each.
Hind quarter of Beef	1¼d.		

instance, in London alone, there are more than 100 persons largely and specially interested in the trade in feathers and bird-skins, either as feather merchants, dealers, purifiers, plumassiers, naturalists, and such like. The declared annual value of the foreign feathers we receive is returned by the importers at nearly £400,000, and the feathers obtained at home for bedding and ornamental purposes may be estimated at about half that sum.

A light and trivial thing, certainly, does a feather seem, and yet what a marvel of skill and beauty is comprised in its mechanism and adaptation. How little are these regarded by the thousands who wear them, and throw them carelessly aside. Few, even, have any idea of the extent of the trade and capital involved in the collection, commerce, and application of these extensive spoils from the feathered tribe. A cursory walk through the Natural History rooms of the British Museum will give us some slight notion of the great variety and brilliancy of plumage of numbers of birds which are now sought after by merchants and traders, who pass their skins or feathers into the hands of the plumassier for the uses chiefly of the ladies.

For the spoils from wild birds, many a fowler, sportsman, hunter, and fisherman is ever on the look-out, on land and on sea. If the various birds, annually slaughtered for their plumage, could but be brought before our gaze in one collective body, what a varied and darkening flight would be presented to us! From the icy regions of the poles; the storm-beaten islets of the oceans; the woods and forests of Asia and America;

the groves of the Eastern Archipelago; the sea-shores of India and Africa; the pampas of Patagonia; the deserts of Central Africa; the plains of Australia, and the poultry-yards of Europe—the peckers, the scratchers, the runners, the waders and stilt-birds, the web-footed swimmers and divers, nearly all the families of the great tribe Aves would be there in flocks, as representatives of the numerous uses to which man, in different countries, applies their integuments, for quills and feathers in the arts and industry; for upholstery purposes; for decorative adornment of the person, or more absolute clothing in warm garments.

Our foreign imports of bed-feathers only amount to a few thousand cwts., but the annual quantity used in the kingdom, has been estimated at 700 tons; a very large quantity, when the lightness of the substance is taken into consideration: to fill a small-sized bedtick, about 27 lbs. are required.

The aggregate value of our foreign commerce in feathers is larger than would be generally supposed. Here are the import figures for 1869 and 1870:—

	1869.	1870.
Feathers for Beds	£80,280	108,505
Ostrich Feathers	145,237	176,797
Other sorts	61,729	73,834
Quills	7,958	20,966
Down	7,239	10,369
	£302,443	£390,471

The fashion of wearing plumes in ladies' hats, so long continued, has given a great impetus to the trade in bird-skins, leading to the introduction of continual novelties.

A new and very pretty ornamental application of feathers is that of the entire head and plumage of some birds for fans and fire-screens; and the brilliant heads of many of the humming-bird family, mounted as necklets, ear-pendants, and brooches, form a novel species of jewellery.

The elegance of the feathers of the ostrich, arising from their slender stems and graceful barbules, has caused them to be prized in all ages. They are the dearest and most sought after of any feathers, in consequence of their fineness and elasticity, and because they can always be cleaned, dyed, and re-made into larger and richer plumes, by patience and assiduity in the attachment. Their average value, taking into account quality and demand, in a series of years, has ranged from £8 up to £55 the lb. weight. We received in 1869 upwards of 64,000 lbs. weight, of which more than half were black ostrich. In 1870 the imports were 66,063 lbs., of which upwards of 39,000 lbs. were black ostrich.

Vulture plumes, or bastard ostrich, egret, grebe and swan skins, and cocks' feathers, are some of the other large articles of commerce in feathers.

The general's plume is of cocks' feathers, white and dyed red; those worn by officers on the medical staff, are dyed black and bronzed; staff-officers and deputy-lieutenants of counties, wear plumes of swans' feathers.

The universal steel pen has almost driven out of use the old goose quill, and, like sealing wax and wafers, they are fast passing out of the stationery trade. In 1855 we imported nearly 26,500,000 of foreign goose and swan quills, valued at about £30,000; but in

later years we only took about 9,000,000, worth about £8,000. There was, however, a remarkable recovery in this respect in 1870, for 27,500,000 quills were imported, of the value of nearly £21,000.

Silk now forms one of the most important articles of consumption for the purposes of dress and luxury, and it is satisfactory to see this gay material becoming every day the property of a wider circle of consumers. Silk is both an agreeable and a healthy material. Used in dress it retains the electricity of our bodies; in the drapery of our rooms and furniture-covers it reflects the sunbeams, giving them a quicker brilliancy, and it heightens colours with a charming light. It possesses an element of cheerfulness of which the dull surfaces of wool and linen are destitute. It also promotes cleanliness, and will not readily imbibe dirt. Grace and Beauty, even, owe something to silk. You cannot stiffen it like thick woollen or linen, without destroying all its gloss and value. The more silk ribbons, silk kerchiefs and robes are used instead of linen and wool, the more graceful becomes the outward aspect of mankind. The quantity of silk now consumed in Europe is four or five fold what it was at the beginning of the century. The stiff brocade, the massy velvet, the slight gauze and the beautiful blonde are alike produced by the labour of the little silkworm.

Much of our silk trade has gone to the Continent. The number of operatives now engaged in the factories—48,000—is scarcely as many as there were in 1850; but the number of factories has risen in that period from 277 to 696, the power looms from 6,000 to 14,400.

The quantity of raw and thrown silk imported in 1850 was 5,462,000 lbs. weight, and the manufactured silk, broad stuffs and ribbons was 687,451 lbs. weight, besides 751,877 pieces of Indian silk. The quantity of raw and thrown silk imported in 1870 was 6,566,907 lbs. The manufactured silk received was 5,704,961 lbs., being an increase of over 5,000,000 lbs.; but the Indian silk pieces had declined to 99,565, an enormous decrease.

The declared value of our silk manufactures and yarn exported was, in 1850, £1,255,641; and in 1870, £1,447,657, so that, notwithstanding the increased large home consumption, we have also been able to send away larger supplies to the United States, to our Colonies and the Continent.

A curious trade was carried on during the silkworm disease on the Continent in silkworms' eggs from Japan, and this is even still continued, to Europe, America, and our Colonies, to some extent. These cards were sent in well-ventilated cases by special steamers, about 220 cards in a case. 100 cards weigh on an average 23 lbs. From 2,000,000 to 3,000,000 of these cards were sent annually, the value being £600,000 to £1,000,000 sterling for this small article. Some were imported here.

The woollen manufacture is the second in importance of our great textile industries, giving employment to more than 250,000 operatives. It is chiefly divided into the woollen and worsted trades; the former using, for clothing, short or fine wool; the latter combing, or long wool.

I pointed out in my former lecture the increase of our manufacturing industry, as shown by the consump-

tion of vegetable products in our textile factories. Let us now see how the case stands as regards the progress of fibrous materials derived from the animal kingdom.

The following were the raw materials used in the United Kingdom in 1790 :—

Wool	lbs.	3,245,352
Silk	„	1,253,445

Now let us trace the progress made in wool in the nineteenth century—

WOOL—SHEEP AND LAMBS ONLY.

		IMPORTS.	CONSUMPTION.
1840	lbs.	49,436,284	48,421,650
1850	„	74,326,778	59,938,104
1860	„	148,396,577	117,634,710
1870	„	259,361,963	166,819,579
1871	„	319,511,336	172,452,719

Why are all manufactured goods now more abundant than in the early part of the century? Because every man works with better tools, and more manual skill and dexterity; because all modes of transit have been improved, thus facilitating the transmission of goods, either raw material or finished, thereby reducing one great element of the price—the cost of carriage; and because, further, the facility of transport has rendered exchange practicable and easy, when formerly it was impossible, thus actually creating new industries.

VALUE OF THE EXPORTS OF BRITISH WOOLLEN AND WORSTED MANUFACTURES AND YARN.

1820		£5,586,948
1850		10,040,330
1870		31,831,217
„	British Wool	580,570
1871		33,296,481
„	British Wool	824,524

In 1851 the quantity of wool used in the United Kingdom was 325,000,000 lbs, the value of the manufacture over £30,000,000 sterling, and the persons directly or indirectly dependent on the manufacture, were computed at 1,500,000.

It is curious to trace the changes in the sources of our supply. In 1840 we obtained the bulk of the wool —31,500,000 lbs.—for our factories, from Germany, Spain, and other parts of Europe. Australia then sent us under 10,000,000 lbs. Now the proportions are entirely reversed, for out of the 259,362,000 lbs. which we received in 1870, our Australasian colonies sent us 175,000,000 lbs., the South African colonies, 31,750,000 lbs., and British India, 11,000,000 lbs., whilst Europe furnished us with but 23,500,000 lbs., or about one-third less than it did thirty years ago.

In 1851 our imports of wool from Australia were under 42,000,000 lbs., in 1871 they exceeded 182,753,000 lbs.

As an instance of rapidity in manufacture, I may state a curious fact which is recorded, although only one of many instances of a similar kind:

At Newbury, Sir John Throckmorton made a wager of a thousand guineas that at eight o'clock on a particular evening he would sit down to dinner in a well-woven, well-dyed, well-made suit of clothes, the wool of which formed the fleece on the sheep's backs at five o'clock that same morning. Two sheep were shorn, the wool was washed, carded, slubbed, rove, spun, and woven, the cloth was scoured, fulled, tented, raised,

sheared, dyed, and dressed, the garments were made, and at a quarter-past six in the evening Sir John sat down to dinner, at the head of his guests, in a complete damson-coloured suit thus made, winning his wager, with one hour and three quarters to spare.

Besides sheep's wool, we import the fleeces and hair of many other animals; that of the alpaca of South America has become an important article of commerce. The staple is of extraordinary length, and of a singularly soft and silky quality, and, when carefully managed, loses nothing of its gloss in dyeing and finishing. The use of it has rapidly extended in the worsted factories of Yorkshire, especially by improved processes. The quantity of alpaca wool imported from 1836, when Sir Titus Salt made his first purchase, to 1840, averaged 580,000 lbs. per annum. In 1850 the import had reached 2,000,000 lbs.; in 1870 it was nearly 4,000,000 lbs., and the price, which was at first but 10*d.* per lb., has risen to 2*s.* 6*d.* per lb.

Nearly contemporaneous with the introduction of alpaca wool, was the bringing into general use in Yorkshire of an article similar in many of its properties, namely, mohair, or goat's wool. This article is of very ancient use in manufactures, having been employed, as we are taught in the Book of Exodus, for the furniture and covering of the Tabernacle. The wool is grown in the neighbourhood of Angora, in the centre of Asia Minor. Although many attempts have been made to extend its growth beyond this immediate district, especially in the Cape Colony and Australia, they have, hitherto, generally failed. This wool is

worked up in Yorkshire chiefly into cloth for ladies' dresses, of great softness, lustre and brilliancy. Our supplies fluctuate much; the average, some twenty years back, was 3,000,000 to 4,000,000 lbs.; a few years ago it rose to 7,000,000 lbs., and has since fallen again to half that quantity.

TEXTILE FACTORIES IN ENGLAND AND WALES, 1870.

	Factories.	Spindles.	Power Looms.	Operatives.
Cotton .	2,371	36,304,958	411,336	414,970
Wool . .	1,550	2,193,324	37,356	100,640
Shoddy .	120	133,793	2,690	3,816
Worsted .	599	2,058,876	63,445	103,514
Flax . .	155	402,288	3,048	19,816
Hemp .	30	4,173	77	2,333
Jute . .	10	10,608	478	1,932
Silk . .	692	2,017,798	12,135	47,311
Hair . .	31	...	...	1,833
Lace . .	223	...	...	8,268
Hosiery .	126	...	...	8,995
Elastic .	61	48,892	1,728	4,623
	5,968	43,174,710	532,293	718,051

SCOTLAND.

	Factories.	Spindles.	Power Looms.	Operatives.
Wool . .	218	469,524	10,543	23,000
Worsted .	28	71,556	1,201	5,968
Flax . .	191	330,599	17,419	42,917
Hemp .	2	24,172	30	463
Jute . .	48	100,324	3,744	14,911
Horsehair .	5	...	...	485
Silk . .	4	12,643	243	813
Hosiery .	3	...	...	697
	499	1,008,818	33,180	89,254

IRELAND.

	Factories.	Spindles.	Power Looms.	Operatives.
Cotton .	14	125,929	3,437	4,157
Wool . .	61	29,895	241	1,490
Worsted .	3	1,020	10	75
Flax . . .	154	886,660	14,834	55,039
Hemp .	3	3,966	...	354
Jute . .	5	4,224	108	727
Hair . .	1	...	...	21
Total :—				
IRELAND	241	1,051,694	18,630	61,863
ENGLAND	5,968	43,174,710	532,293	718,051
SCOTLAND	499	1,008,818	33,180	89,254
Total .	6,708	45,235,222	584,003	869,168

Bristles—the hard, strong, shining hairs, which form the manes of wild boars and hogs—are imported chiefly from Russia for the use of brushmakers, shoemakers, and saddlers, and are worth 3*s.* a pound. The annual imports average from 2,000,000 to 3,000,000 lbs., valued at about £300,000. During the war with Russia the brushmakers were sadly inconvenienced by the stoppage of supplies; and, as I stated in my last lecture, various substitutes were brought into use, consisting of strong vegetable fibres and grasses, which, having proved cheap and serviceable, still hold their ground. The importance of suitable materials for the brush trade will be understood when you are informed that the value of this one article in all its varieties is estimated to be over £2,000,000 sterling.

Of the hair of various animals we receive considerable quantities, especially horse-hair, goats' hair, and camels' hair; even human hair is of importance in trade. The imports of human hair have largely

increased from the Continent. In 1861 we received 15,672 lbs.; in 1870, 33,875 lbs., valued at £27,098. Now, as the average weight of the clip of a woman's hair is only about 8 oz., this represents the spoils of 67,750 females who have deprived themselves of their beautiful locks for the sake of gain to themselves and profit to the hairdressers.

Aggregate quantity and value of hair of all kinds imported in the years 1869 and 1870 :—

1869.

	Quantity.	Value.
Bristles or Hogs' Hair......	2,004,900 lbs.	£289,140
Camels' Hair..................	401,931 lbs.	10,650
Human Hair..................	22,199 lbs.	17,758
Horsehair	19,857 cwts.......	152,631
Cow Hair	65,799 cwts.......	399,179
Unenumerated Hair		33,286
Hair Manufactures		5,257
Goats' Hair do.		64,413
		£972,314

1870.

	Quantity.	Value.
Bristles	2,497,122 lbs.	£366,767
Camels' Hair..................	155,921 lbs.	3,899
Human Hair..................	33,875 lbs.	27,098
Horsehair	14,134 cwts......	127,145
Cow Hair	68,746 cwts......	411,493
Unenumerated Hair		44,061
Hair Manufactures		6,670
Goats' Hair do.		48,092
		£1,035,225

Among animal products of the sea which enter largely into commerce are sponge, coral, mother of pearl shells, cowry shells, pearls, tortoiseshell and miscellaneous shells for various purposes.

The two great sponge fisheries are round the Bahamas Islands, where the common sponge is obtained, and in the Mediterranean, where the superior kinds are fished for. In 1869 we imported 1,250,000 lbs. of sponge, valued at £157,000; in 1870, 837,159 lbs., valued at £160,162; of coral, in 1855, only about 4,000 lbs. were imported; but, in 1869, 7,739 lbs. were received, valued at the high price of £18,834. Cowries are imported chiefly to be sent to Africa for barter. We received in 1869, 7,500 cwts., valued at £8,500. Mother of pearl is imported to the extent of about 37,662 cwts., valued at £94,015; the pearls imported range in value from £45,000 to £100,000 annually.

What is known in commerce as tortoiseshell is strictly the thirteen horny scales or epidermal plates which cover the carapace of the hawk's-bill turtle or sea-tortoise, and one or two other species. The principal consumption is in the manufacture of ladies' back and side combs, dressing and pocket-combs; the minor uses, for optical purposes—more particularly for spectacles, eye-glasses, and frames for microscopic lenses, and for the manufacture of fancy articles. The value of tortoiseshell depends almost entirely on the movements of fashion as regards the head dress of ladies. Thus, the ungainly modes of wearing the hair either loose, dishevelled over the shoulders in artificial negligée, or thrown conspicuously over the face by concealed horse-hair puffs or frissets, or suspended behind in a netted bag, have completely superseded the neat and elegant styles formerly in vogue, and their necessary appendages, side and back combs. At the same time, the tortoiseshell dressing-comb, not

affected by this, was seriously injured by the new appliances of india-rubber and gutta-percha. It is, however, now recovering, as the combs manufactured from those two substances have not been found to answer so well as was expected. In 1859 the import of tortoiseshell was a little over 48,000 lbs., of the aggregate value of £25,500. In 1870 it was rather more, the imports being 49,332 lbs., valued at £32,503, besides 5,703 lbs. of inferior turtle shells, valued at £1,423.

Of insect products we receive, besides silk, some important commercial articles, as, for instance:—

	Value.
Beeswax	£125,163
Cochineal	579,547
Lac products: Shellac, stick lac and lac dye	282,251

Galls and some other products are mentioned in other sections of my discourse.

Of bones we import a large quantity for manufacturing purposes and for manure. In 1850 we received 27,198 tons; in 1870, 94,923 tons. Of these, 4,056 tons were suited for manufacturing purposes, and the rest for manure.

We import about 1,800 tons of buffalo horns from India, valued at £50,000; and of deer horns 1,000 tons, worth £62,000; besides innumerable horns and horn-tips and pieces—2,600 tons, worth £60,000: so that we pay for bones and horns from abroad £170,000. Besides the two chief varieties of horn—those of the ox and buffalo tribe and the stag—there is another which scarcely looks like horn at all, and that is the horn of the rhinoceros, which is a mere appendage of the skin, and formed of the hair matted together.

I incidentally pointed out in my previous lecture what changes take place in commerce by the substitution of new articles for old, and of this, fish-oil and whalebone form notable examples. Vegetable and mineral oils have increased so rapidly as to have greatly reduced the value of whale oil, and the expensive and hazardous fishery has been almost given up by our merchants, and in America entails heavy losses. Whalebone has been largely superseded in its various uses by steel and cane. The whales have in the place of teeth extensive rows of baleen plates, or "blades," as they are commercially called, ending in a fringe of bristles. Messrs. Bovingdon, Allen and Co., of Fell Street, whalebone merchants, have kindly lent a fine fin of the Greenland whalebone, Davis' Strait fishing, from the Arctic whale, *Balæna mysticetus*, measuring 12ft. long; a fin of southern whale, *Balæna australis*, and fins in clump from the bottle-nose or humpback whale, *Megaptera americana*.

For ivory purposes we import on the average about 12,000 cwts. a year of the tusks of the elephant, called in the trade returns "elephants' teeth," which they are not, though the teeth or grinders are sometimes used for knife handles and other purposes, but they are brittle and faulty. The defences of the sea-cow, or hippopotamus, the walrus or sea-horse (*Trichecus rosmarus*), and the ivory protuberance of the narwhal (*Monodon monoceros*) also come in for ivory. The ivory of the sea-morse used to be preferred by dentists for making artificial teeth, but has been much replaced by composition mineral teeth. About half the ivory we receive is sent to the Continent;* the remainder is

chiefly worked up at Sheffield for knife handles and fancy work. As we have imported since 1840, 13,342 tons, if we average the tusks at a quarter of a cwt. each, there will have been slaughtered in that time nearly 500,000 elephants ; but some allowance must, perhaps, be made for tusks shed or found.

ELEPHANTS' TEETH, SEA COW, AND SEA HORSE, OR SEA MORSE TEETH IMPORTED.

	Imports.	Re-exports.	Computed Value of Imports.
	cwts.	cwts.	£
1840	5,469	1,494	
1841	5,811	1,297	
1842	6,429	1,482	
1843	5,462	1,423	
1844	5,229	1,701	
1845	6,402	2,005	
1846	5,394	1,200	
1847	6,477	1,526	
1848	5,146	955	
1849	7,457	1,357	
1850	9,396	2,743	
1851	6,356	2,494	
1852	9,515	3,673	
1853	10,388	2,823	
1854	9,299	2,510	230,420
1855	8,376	2,580	219,964
1856	9,866	2,942	343,517
1857	9,890	2,780	421,318
1858	12,279	3,016	410,608
1859	10,821	3,313	336,147
1860	10,854	3,463	332,166
1861	11,163	4,193	297,491
1862	11,605	4,821	262,962
1863	9,290	5,696	256,059
1864	11,497	5,738	361,384
1865	10,268	6,588	322,286
1866	11,982	6,143	445,335
1867	10,343	5,750	360,520
1868	9,909	5,985	337,403
1869	14,599	5,911	507,319
1870	12,590	4,039	439,839

Total since 1840.................279,565 cwts.

And now time warns me to conclude.

It may appear to you that I have dwelt too much on figures, but Statistics in regard to nations have been very appropriately compared to the ledger of a merchant. Now, if a merchant suffer his ledger to be carelessly or erroneously kept, or if he keep no ledger at all, there is an axiom among commercial men that, "some one else will take his business from him and take care of it." So it will be with the country in which a just and efficient mode is not adopted of ascertaining the extent of its trade; whether this trade is profitable as a whole; what particular parts of it are most profitable; what branch should be most encouraged, and numerous other considerations, which, in order to be profitably treated, must have just data upon which they should be based. It is of primary importance, then, that these data should not only be at the fingers' ends of our statesmen and legislators, but that the educated portion of the people in general, and the commercial body in particular, should be thoroughly acquainted with the different phases of the trade and resources of the country.

In bringing my observations to a close, I can but regret that my remarks have necessarily been somewhat discursive and superficial, owing to the wide range of subjects with which I have had to deal.

It is, certainly, highly satisfactory to me to find such large audiences attending, interested in acquiring sound practical information. For a long series of years, in various technical publications of my own, and before different institutions, I have endeavoured to diffuse

scientific and commercial information; but it is only very recently that the public generally has taken an earnest interest in the acquisition of scientific and technical knowledge: and the more this feeling is developed and encouraged, the better will it be for our individual and national progress.

LECTURE III.

THE MINERAL AND VEGETABLE PRODUCTS OF COMMERCE.*

I have been invited to address you upon a subject so vast in its range, that not a short hour and a single lecture, nor, indeed, a whole course of lectures, could enable anything like full justice to be done to it. When one has for a theme "The Mineral and Vegetable Products of the World," he may well be puzzled in what manner to treat it. In justice to myself, therefore, I may state that I should never have chosen so ambitious and comprehensive a topic for a dissertation, because, as you may well conceive, it would be utterly impossible even to enumerate the chief products in the brief time I can conveniently trespass upon your patience, much less to describe them. One product alone would have formed a most difficult subject to do proper justice to in a lecture, even if it were the commercial products of the cocoa-

* A Lecture delivered before the Birmingham Institute in January, 1859.

nut, the sugar-cane, cotton or flax, coal or iron. To attempt to squeeze all, therefore, into the compass of a short discourse would be like the resulting process of passing the sugar-cane through the mill rollers, when you would obtain a little sweet juice and a great deal of refuse or trash. I shall, therefore, take the liberty of dealing rather with generalities than specialities, confining myself to our own commerce, and touching chiefly upon those most prominent articles in which individuals of the British nation are principally interested.

The nature of the subject to be discussed may require, however, a further word of apology at the outset. Those amongst you who are usually engaged in the active pursuits of trade and commerce, may feel inclined to protest against the revival in this place of considerations which are the occasion of continued anxiety during many hours of every day. Away from the counting-house or the mart, they desire to forget those details which engage the mind in such places, and they rightly determine to avoid the intrusion of matters of business during the hours appropriated to relaxation and enjoyment.

While another portion of my auditory will hardly be disposed to take a different view of the subject; they hear the course of daily business often spoken of as "weary, flat, stale," and even sometimes "unprofitable;" they know nothing of these concerns, and regard them as belonging to a department of life with which they really have nothing to do; it is most true that they are deeply interested, as well as ourselves, in the results of trade and commerce, and

these daily labours; but its peculiarities and contentions, its details and calculations, are all unsuitable to the female mind. But the unsuitableness of the subject is more imaginary than real; it includes the products of almost every clime, and bears witness to the industry and occupation of almost every nation. Although I am shut out from noticing animal substances, my subject combines all the resources of the vegetable and mineral world. And, did I possess the wand of the enchanter to invoke them, I might array before you the various productions which exist in such wonderful profusion over the globe, and which are so marvellously suited to our common wants, that in them we see the most certain evidence that He who has created man for existence in this world, hath abundantly furnished it with everything which can tend to his nourishment and support, the development of his intellectual faculties, the civilisation and refinement of his character and feelings.

The cotton and flax from which our apparel is made, the thousand nutritious aliments which support and invigorate the body, the various materials used in giving solidity and comfort to our habitations, and all the visible sources from which our avocations, and much of our enjoyments, are derived, come fairly within the range of my lecture.

"The vast and boundless mineral treasures which, drawn from the earth, have ever afforded occupation to a large portion of its inhabitants, while they have materially conduced to the common benefit of all—these, and ten thousand other products, appear in the mind's eye before us, and along with them the

wants and necessities of man, not only as regards his bodily requirements, but in much that tends to his moral, intellectual, and social refinement."*

The scope of the subject comprehended under the title of my discourse is so extensive that it is difficult to know under what aspect it may be most tersely and graphically sketched. It might properly be arranged under several groups, which would make it more readily understood. Thus we could discuss :— 1. The products of the soil, whether obtained by the labours of the agriculturist, or the spontaneous production of Nature. 2. The products of the mines. We might examine the foreign products we receive in several points of view, as—articles of necessity, articles of convenience, and articles of luxury, refinement, or indulgence. Or we might view them under another aspect, and investigate the economic and commercial uses of the different parts of plants: for instance, commencing with the roots, proceeding to the stem, the sap, the bark, the leaves and flowers, the fruit or seeds, and such like, and we should be surprised in the progress of this investigation to find how largely each of these contributed to the wants and comforts of man, and what an extensive commerce is carried on in almost all of them. But I cannot follow any of these systematic arrangements, and must, therefore, be content to take a somewhat discursive view of the subject in its several relations, guided by the time at our disposal. My subject,

* From a Lecture on the "Commerce of London," by Mr. Howell.

although not probably at first sight so interesting as some of those to which you have listened in previous sessions, is yet, as I have told you, of high individual and national importance, and very varied in its range and character. As we proceed with its discussion it will be found to come home to the individual wants and comforts of each of us, and to afford large scope for inquiry and reflection. When we compare the present with the past, and see how year by year our ease, health, and comfort are promoted by Commerce, we must fain acknowledge our vast indebtedness to the capital and enterprise of our merchants. "There is probably," observes a high commercial authority,* "no index of a general kind by which the material condition of a country can be more accurately tested than the extent of its foreign trade. By whatever means the external commerce of a nation is conducted, and by whatever laws it is regulated, its imports must be limited in the long run by its own surplus production. It is, therefore, only in proportion as that surplus is great or small, that a country is in a condition to command the surplus products of other countries; and it is the extent of this ability to exchange that determines the amount of its foreign trade."

The peasant or mechanic of to-day, whether we regard his food, clothing, dwelling, or amusements possesses far greater advantages than were enjoyed by the monarch of a century or two ago. And to what does he owe this? Is it not to the extended and cheapened products of Commerce?

* "Economist," January 15, 1859.

Railroads, steam, the discoveries of Science, the printing press, the electric telegraph, and the progress of colonisation have materially altered the condition of society, even in the last quarter of a century, and in no one feature is there so marked a change as in the character and extent of British and Foreign Commerce. Let us primarily look at the aggregate value of British commerce.

A few figures will show its amazing strides at decennial periods within less than fifty years.

Taking first the official value of our imports—which *official* value I may observe is an incorrect data, founded on an antiquated standard of prices fixed on commodities, all of which have varied materially—we find that the official value of imports was:—

In 1820	£30,792,760
1830	49,713,890
1840	65,873,411
1850	100,469,067

In 1857, the *computed real value* was £187,844,441; in 1869, £295,460,214.

Now even by this criterion we find that the aggregate value increased six fold in thirty-seven years—to 1857.

Next we have the official value of our exports, and these stand as follows:—

In 1820	£51,461,434
1830	71,429,005
1840	116,029,130
1850	197,311,310
1857	146,174,301
1869	189,953,957

These figures are also steadily progressive, almost in the same ratio, except within the seven years to 1857;

this difference arises from our having more precise and reliable data in the computed real value of both imports and exports, which are now assessed at their true market values.

It is curious to trace the rapid growth of British commerce even in the present century. But how does it compare with five centuries ago?

In 1354 the total value of the imports into England, with the Custom's duty added, was £38,872, and consisted only of the following items :—

1,831 pieces of Cloth, valued at £6 each	£10,986
397¾ cwts. of Wax, at £2 per cwt., with the customs..	815
1,829½ Tuns of Wine, at £2 per tun, do. do.	3,842
Linen Cloth, Mercery, Groceries, and all other Wares..	23,229
Total........................	£38,872

What a contrast in prices and quantity with the import trade of the present day (1869), when the value of the imports was £269,460,214!

In 1710 the imports and exports collectively amounted in value to but £10,000,000; in 1800 to £69,000,000; in 1850 they had risen to £297,000,000; and in 1869 to £532,500,000.

When you learn that the estimated average annual products and manufactures of the United Kingdom (home consumption, imports, and exports) amount in bulk to 400,000,000 tons, and are valued at close upon £1,000,000,000 sterling, you will the more readily comprehend and appreciate the extent and importance of the subject we are about to discuss.

We have been stigmatised as a nation of shopkeepers; but there is certainly nothing petty in our transactions, which are on a gigantic scale, and embrace the chief trade of the world. For we are their carriers, their bankers, their manufacturers, their warehousemen, and their purveyors.

Albert Smith in his interesting narrative before a London audience used to tell us that statistics are a great bore, and that the traveller on the Continent cares as little to know whether a town has 200,000 inhabitants or 10,000, for the figures in the one case or the other will find no resting-place. Now figures are, no doubt, very often troublesome things to form, to calculate, or to remember, and they may often become tedious and wearisome, especially when unduly quoted to a general audience. But I venture to assume that there are many here who are seekers after information; and some who are desirous of storing their memory with facts, whilst every one has not the opportunity of searching voluminous blue books, consular reports, trade circulars and returns which appal those who first attempt to wade through them.

I cannot but agree with a recent author that statistics in general are facts from which truth is elicited, and the advantages derived from them are incalculable. They exhibit the state of the world and of nations; they afford the greatest assistance in the correction or confirmation of opinions, and influence the progress of legislation. Without them the conditions of society, the increase or decrease of population, wealth, poverty, disease, or crime would be unknown; and any correct reasoning upon the reme-

dies would be impossible. If we consider them aright

> "Every line furnishes a moral,
> Every page a history."

Great Britain is truly the workshop of the globe. Her Commerce stretches far beyond the bounds of civilisation; her dry goods are worn by all the tribes of the earth; whilst our hardware may be found in the homes of almost all the members of the human family.

To the preliminary facts already cited illustrative of the commercial power of Great Britain, I may add that the capitalists of this country own an immense amount of foreign stocks, not only in Continental Europe and India, but all over the American Continent. Of £50,000,000 of foreign capital invested in North American securities, the great bulk is owned by British capitalists. Is a loan wanted for Turkey or Russia, for Buenos Ayres or Spain, John Bull finds the funds. Is a Pacific railway, or a submarine-cable, or an ocean line of steamers to be formed, British capital is drawn upon.

Whatever our walk in life, we are all more or less identified with, and interested in, Commerce, either as dealers, producers, conveyors, or consumers. The day has gone by when men scoffed at the trading or manufacturing classes.* Our merchant princes, our

* Dr. W. B. Hodgson, Professor of Commercial and Political Economy and Mercantile Law in the University of Edinburgh, in one of his lectures well remarks that—

"Trade is often spoken of as if it concerned only a portion, and that the lower, of the community, though the more

shipowners, and our wealthy and intelligent manufacturers now take rank with the most noble of the land, and are the leaders in every great movement of progress or improvement. The pressure from within

numerous. We distinguish tradesmen from gentry, from professional men, often even from merchants; and a recent well-informed writer speaks of 'uncommercial cities like Edinburgh, where men live by the learned professions only, and scorn trade in the old sense of the word.' But 'trade' means simply exchange, and exchange (twin-sister of division of labour) is the one universal and inevitable characteristic of all society removed ever so little from barbarism. Thus, with pardonable exaggeration, some propose to call economics 'the science of exchange.' It is significant that the word trade has largely absorbed into itself production as well as exchange. Thus, we often speak of weaving or baking as a trade; and the reason is that every producer must exchange; the shoe-vendor need not be a shoemaker, but the shoemaker must be a shoe-vendor. Therefore do we speak of shoemaking as a trade. Now, it is only by exchange of service—that is, by trade of some kind—that any of us live. We do not all literally keep shops, but in essence, in principle, we do. To be a nation of shopkeepers is no disgrace. The disgrace would be were we a nation of brigands, calling slaughter and rapine glory, grudging the prosperity of other nations as an insult and injury to ourselves, and hoping to profit by the ruin of our neighbours. We are a nation of shopkeepers, and must be if we would live honestly. 'The way to strip nick-names of their sting is for good men to take them up and wear them.' In no figurative or very remote sense, the banker, the accountant, the lawyer, the physician, the artist, the teacher, even the professor, all keep shops as well as the grocer. They all live by selling the commodity in which they deal. The landowner himself, through his tenants, or directly, trades in the products of the soil; his shop is the oldest of known establishments, and is 'never removed.' Through superficial distinctions the economist detects the central unity.

has sent out to distant lands thousands who, nevertheless, still cling fondly to the ties of the mother-country, and who help on her progress and wealth, while they at the same time advance their own posi-

He recognises no difference in dignity or utility between wholesale and retail, between sugar in the hogshead and sugar in the paper bag. In his eyes, as in Scottish phrase, the humblest and most miscellaneous dealer is still a 'merchant.' To him salary and fees and stipend, and even *honorarium*, are only euphemisms for wages; to him even the Prime Minister is but a highly-skilled labourer, highly but not exceptionally paid, a subject of what it is fashionable now to call 'wages-slavery.' The economist smiles at, while he deplores, the superciliousness with which traders of one kind look down upon traders of another; at the delusion of those who fancy themselves high-lifted up above all trade; and at the littleness of some who, having thriven by honest trade, would fain hide the fact, as if they blushed for it, and so 'turn their backs upon themselves.' No calling can degrade the noble, or dignify the mean, for

'True gentrie standeth in the trade
Of virtuous life, not in the fleshly line;
For bloud is brute; but gentrie is divine.'

"The spirit thus expressed has much to hope from economic teaching. Exchange is but the economic phase of human brotherhood, of mutual dependence, each providing for others' wants directly, and only indirectly for his own. The much calumniated maxim, 'Buy in the cheapest and sell in the dearest market,' means simply—Take a thing from where it is least, to where it is most, wanted, in return for something else that is also more wanted by him who buys than by him who sells. It is not inevitable, it is not desirable, that those who conduct any portion of this doubly beneficent process should be ignorant of the high utility which individually they subserve, unable and indisposed to look one jot beyond their own individual gain. This inability, this indisposition, it is the clear tendency of economic studies to remove.

tion, and carve out fame and fortune by their honest industry in those new lands which invite the enterprise of men who find the battle of life too stern for them to contend with here.

The vast services which the merchant has rendered to mankind, in relation to his material comforts, have been sufficiently acknowledged; but his agency in the civilisation and moral improvement of his race has hardly been properly considered.

That the educated, intelligent Anglo-Saxon merchant, whether of the senior or junior branch of the family, is a prime agent in the work of human civilisation no one will be disposed to deny. He penetrates into every known region which is accessible to the camel, the ship, or even to the human footstep, and may say with the Ancient Mariner, that he passes like "night from land to land," to exchange not merely the productions of the lands of different and distant people, but in some sort, the productions of their minds also, their modes of thought and moral culture.

Commerce has been personified as the handmaiden of the Arts, the purveyor of human wants, luxuries, and desires. She is all this and more. She may with truth be designated as the precursor of civilisation; the mother of geographical discoveries; the missionary of Christianity; the minister of peace, liberty, and happiness; in a word, the fast, active, and powerful friend of man.

The office of Commerce has been to carry into effect a law of nature, by aggregating individuals geographically divided; to increase our capabilities of

enjoyment and happiness; to multiply our wants and desires, with the ability of gratifying them; to subdue hostilities; to remove prejudices and antipathies; and to humanise, civilise, and Christianise the mind and heart, and make them capable of enjoying to the full all the blessings of a munificent Providence.

There is one truth that may prominently be placed before you, and that is, that wherever Christianity has thriven Commerce has thriven.

If Great Britain and America at this moment, with an aggregate population of less than 70,000,000 of souls, own nearly all the shipping of the civilised world, and if their energy and enterprise furnish an example to all the nations under heaven, and if the spirit of their commerce be literally infused into all nations, the question very naturally arises, how did these nations, bearing such a close blood-relationship become so truly great, and what is the secret of all their commercial power? It is not found in the numerical strength of their population. British India would outnumber them threefold; China possesses five or six times their combined population. It is not found in their legislation, for the two systems are essentially different, the one being a monarchy and the other a republic. The only fact, then, which accounts for the triumphs of British and American Commerce over that of all the other nations of the globe, is, that Christianity has sanctified and ennobled the enterprise of these two nations. Long may this be the distinctive characteristic of our race! Long may it ennoble the death-struggle of the civilian or the soldier in the battle-field of self-defence, or go

with the missionary consul to civilise the African race!

And now it is time to enter a little more into detail upon the bearings of my subject, and, first as to mineral products.

The coal trade of Great Britain for extent and value is unparalleled in the annals of commerce, and has gone on increasing year by year until the average annual production has now (1858) reached 66,000,000 tons; estimating this in value at ten shillings per ton gives an annual value of £33,000,000 sterling for this one mineral product.*

But although our own collieries are those which are most largely developed for domestic purposes, and for our manufacturing industries, the produce of coal is not restricted to the British Islands, but is, happily, very generally diffused over the globe, and will in future years be more extensively drawn upon for the wants of man than it is now.

* It was in 1870, 110,431,000 tons, valued at £27,600,000. In the three centuries before 1800, it is computed that not less than 850,000,000 of tons of coal were raised from the coalfields of the kingdom. During the next fifty years there was a constant and steady increase in the production, and fully 2,000,000,000 of tons of coal were extracted. Up to this time the records of coal produce were most imperfect, and it was not until the year 1854 that reliable returns came into existence. The average production in 1851, 1852, and 1853, may be taken at 50,875,000 tons per annum. In the years 1854 to 1869, both inclusive, 1,343,793,705 tons were raised, which, added to the figures above given, and taking the return for 1870 at 110,000,000 tons, shows that we have already drawn from our original stores, not less than 4,456,000,000 tons of fuel.

The mineral produce of the United Kingdom in 1857 (exclusive of clays and stones) was valued at £26,000,000 sterling; and the metals, as obtained from the furnace, at the market prices of the year, at £18,000,000, making together a total of £44,000,000.* These figures will convey some representation of the important mineral industries of these islands in their crude or rough state, before they have acquired that higher value which they receive when fashioned by the hand of science and skill into the many useful articles, from the tiny needle and pin or steel pen, to the more massive and elaborate steam-engine, iron ship or dwelling.†

* The figures for 1870 were—

Minerals raised	£37,142,194
Metals obtained from the Ores	18,486,802
Other Minerals not smelted	1,851,700
	£57,480,696

Exclusive of Slates, Common Clay, Building Stone, Lime, &c.

† There was a steady and rather considerable increase in our production of coal in 1870, which amounted to 110,431,192. The manufacture of pig iron shows a corresponding increase; 5,963,515 tons having been made, representing an increase in the consumption of coal for this manufacture alone of not less than 1,553,274 tons in 1870. The data for estimating the actual quantity of pig iron which was converted into bar iron, &c., are not readily obtainable; but, in this manufacture, 3 tons 7 cwts. of coal are required for the manufacture of each ton of finished iron, every operation included. We may, therefore, estimate an increase of at least 600,000 tons in the consumption of coal for this branch of iron manufacture. Our exports of 1870 show an increase of 742,933 tons. These quantities will very nearly account for the 3,000,000 of increase shown. The iron ore appears to show an increase over

One of the great features of the present age is the triumph of practical science, and the bending of lifeless matter into the service of man.

Iron is every year made more and more to do the work of flesh and blood, and that, too, not merely in the rude department of physical force, but in tasks which require the skill of practised workmen. One species of machinery after another has been invented to abridge human labour. We see it in our mills, our workshops, and our factories. By the year 2000 it is

the production of 1869 to the extent of 2,862,129 tons. This is not an actual increase. In the returns of former years, a considerable quantity of calcined ore was reckoned as such, whereas it has all now been computed into raw ore. The relation between the ore raised and the pig iron made is thus made to approximate much more nearly to the truth. There are nineteen works in Great Britain which have seventy-five Bessemer converters in use, the capacity of these ranging from 3 to 10 tons; and there are forty-four works in various foreign countries using them. The returns of the tin plate manufacture, which were first sought for in 1869, are not yet so complete as could be desired, still the returns approach more nearly to correctness, and the whole make of tin and terne plates in the fifty-seven tin plate works of Great Britain is estimated at 3,459,782 boxes. The number of mines yielding tin was 147, and the produce of ore (black tin) 15,234 tons, valued at £1,002,357. It may be incidentally mentioned that the production of the Dutch tin mines in the East was rather larger than usual in 1870—Banca having yielded 4,672 tons, and Billiton, 2,858 tons. The number of copper mines worked in Devonshire and Cornwall has been declining gradually of late years, and the aggregate produce is also less. There were about twenty works in action in 1870 for extracting metal from Spanish and other coppery pyrites, the consumption of burnt ore being 200,000 tons. Four or five firms make

probable that manual labour will have utterly ceased under the sun, and the occupation of the adjective "hard-fisted" will have gone for ever. We have now steam-ploughs, steam-hammers, steam-saws, steam spinning and weaving machines, sewing ma-

their precipitate into fine copper, the others sell it to the copper smelters, and one or two works make sulphate of copper direct from the ore.

About 10 per cent. of the oxide of iron known as "Purple Ore" (which is the residue of the burnt pyrites after the copper is extracted) is used in blast furnaces; the remainder, say 170,000 tons, is used as fettling ore for the puddling furnaces, it being in a powder does not require grinding, the same as Hematite; the per-centage of iron depends on what pyrites it is made from; when Mason's pyrites are used it contains about 67 per cent. metallic iron, when Tharsis about 62 per cent., and Bintron 66 per cent.

The imports of foreign pyrites in 1870 were 411,512 tons, valued at over £1,000,000, of which 145,705 tons of cupreous pyrites were imported in the Mersey, and 130,686 tons at Newcastle.

The total quantity of iron ore raised in the United Kingdom in 1870 was 14,370,654 tons, the foreign iron ores imported, 208,310 tons. The total of iron ore smelted in Great Britain, 14,578,964 tons. The number of furnaces in blast, 664.

The pig iron produced in 1870 was, in—

	Tons.
England	3,735,627
Wales	1,021,888
Scotland	1,206,000
Total production	5,963,515

The number of works was 255 with 6,699 puddling furnaces, and 851 rolling mills. The shipments of kaolin, or china clay, from Cornwall was 110,520 tons, and of china

chines, and a host of other contrivances to abridge labour.

But in the United States they are far ahead of us in this respect. In New Hampshire they have a potato-digging machine, which, drawn by horses down the rows, digs the potatoes, separates them

stone 32,500 tons; from Devonshire 12,500 of china clay, and of pipe and potter's clay 48,498 tons. Dorsetshire exported 67,579 tons of clay from Poole.

Of potter's materials, clay, flint, chert, &c., the Potteries received 150,430 tons by rail and canal.

General Summary of Minerals raised in 1870 :—

	Quantities.		Value.
Coal....................tons,	110,431,192	...	£27,607,798
Iron Ore	14,370,654	...	4,951,220
Copper Ore..................	106,698	...	437,851
Tin Ore	15,234	...	1,002,357
Lead Ore....................	98,176	...	1,200,209
Zinc Ore	13,586	...	41,058
Iron Pyrites (sulphur ore)	58,428	...	36,026
Arsenic	4,050	...	17,739
Gossans, Ochres, &c.......	4,844	...	4,261
Wolfram and Tungstate of Soda	51	...	653
Manganese..................	4,838	...	19,499
Nickel	½	...	27
Barytes	6,515	...	3,771
Clays, fine and fire (estimated).....................	1,200,000	...	450,000
Earthy Minerals, various (estimated)..............	—	...	575,000
Salt	1,489,450	...	744,725
Coprolites (estimated)...	35,000	...	50,000
Total value of the Minerals produced in the United Kingdom in 1870......			£37,142,194

from the dirt, and loads them up into the cart, while the farmer walks alongside, whistling "Hail Columbia," with his hands in his pockets.

To such an extent has machinery progressed among ourselves, that Great Britain, with its comparatively small population, contains a greater amount of dynamical resources than any other country in the world. At the close of 1856 we had in the factories of Great Britain, employed in spinning and weaving alone, motive power in steam equivalent to 132,000 horses, and 21,000 horse-power moved by water, to say nothing of the other great industries employing steam.

The average consumption of iron with us, exclud-

Metals obtained from the Ores enumerated, &c., in 1870 :—

		Quantities.		Value.
Iron, pig	tons,	5,963,515	...	£14,908,787
Tin	„	10,200	...	1,299,505
Copper	„	7,175	...	551,309
Lead	„	73,420	...	1,452,715
Zinc	„	3,936	...	74,096
Silver	ounces,	784,562	...	196,140
Gold	„	191	...	750
Other Metals (estimated)		—	...	3,500
Total value of Metals				£18,486,802

Absolute total value of the metals and coal with other minerals which are not smelted (excepting building stones, lime, slates, and common clays) produced in the United Kingdom in 1870 :—

Value of the Metals produced	£18,486,802
Value of the Coal	27,607,798
Value of other Minerals	1,851,700
Total value	£47,946,300

ing the exports, and dividing the produce over the population, is 180 lbs. per head, to which has to be added the other metals. We are daily producing from the bowels of the earth a raw material, in its crude state apparently of no worth, but which, when converted into a locomotive-engine flies with a speed exceeding that of the bird, and advances wealth and comfort throughout the country; and by the marine engine or the electric telegraph, enables us amazingly to shorten distances, and to communicate with far-off lands. These are the powers of iron, brought about by the powers of man. There has been obtained from the earth in England in the last quarter of a century more rude stone than, when converted into railway bars, would form an iron girdle round the earth itself.

When we are drawn by iron horses on iron ways, construct iron dwellings, stores, and palaces, build iron ships, sleep on iron beds, sit in iron chairs, drink from iron fountains, when those of us who have money keep it locked in iron cash-boxes and iron safes and strong rooms, and those who have none are locked up in iron gaols, may we not with propriety call this the age of iron?

It is not much more than a quarter of a century ago that a committee of the House of Commons was appointed to examine into the state of steam navigation. The late Earl of Derby was chairman of that committee, and on Mr. Robert Stephenson, the eminent engineer, speaking of the probability of steamships crossing the Atlantic, the noble lord rose from his seat, and exclaimed, "Good heavens! what do

you say? If steam-ships cross the Atlantic I will eat the boiler of the first boat." There were, however, other sceptics besides Lord Stanley; even Dr. Lardner doubted the feasibility of the voyage; and yet what do we find at the present day: the smoke of the steamer is seen not only on the broad expanse of ocean, but in every inland lake and sea of the various quarters of the world—the rivers of North and South America, from the Magdalena and the Paraguay to the Mississippi and the Columbia; on the Orange River and the Niger in Africa; the Indus, the Ganges, the Irrawady, the Amoor; the great rivers of China, and dozens of others in Asia, and the Murray and its tributaries in Australia.

[At the close of 1869, the steam tonnage owned in the British empire and the Colonies, numbered 3,545 vessels, and 1,032,015 tons, and the vessels had doubled in number and in tonnage in ten years. I mention these facts, although a little foreign to the subject under discussion, because they have an important bearing on our Commerce, and steam vessels are now the great ocean carriers for passengers and light goods.

The total produce of pig iron in the kingdom is about 4,000,000 tons. It was in 1870 nearly 6,000,000 tons, and the make is annually on the increase. Scotland made in 1859, 950,000 tons; and in 1871, 1,335,000 tons; in the last twenty years the produce there has been doubled. South Wales is the next largest producing district, and then follows South Staffordshire and Worcestershire. It is scarcely possible to form an estimate of the increased demand

that must arise for iron—the use of which is the great test of material advancement, inasmuch as it enters into all work, agricultural and manufacturing, buildings, railways, and shipping, whether for commerce or for war.

In 1869 there was exported from the United Kingdom upwards of two and a half millions (2,606,326) tons of various descriptions of iron and steel, 54,857 tons of copper and brass, 51,688 tons of lead, and 103,064 tons of tin, wrought and unwrought. In 1871 the exports were 3,171,581 tons of iron and steel, 42,821 tons of copper and brass, and 44,787 tons of lead.]

But there is another metal that is exercising a vast influence on the affairs of the world, its commerce and its inhabitants, and that is Gold, which has created such revolutions within the past twenty years as would scarcely have been credited had they been previously predicted or theorised on. The gold discoveries of California and Australia have almost annihilated the former long and perilous voyages of the Atlantic, Pacific, and Indian oceans; have studded the sea with fleet-winged messengers, and floating hotels and palaces. This gold has attracted population from every quarter of the globe, from every people and language, until thriving States have sprung up with a rapidity which throws all former instances of Colonisation into the shade. Gold has done more than this, it has led to the abolition of transportation to our Australian settlements, and to a foreign and colonial trade which is unparalleled in the records of Commerce. Gold is now assisting the

development of iron; and the same metallic agent which is daily thinning our population by the emigration which it induces,—drawing myriads of our countrymen to distant shores,—is at the same time stimulating our manufactures, and leading to extensive foreign orders for our iron rails and machinery.

This would appear to be the golden era in a literal sense; and if we may judge from the discoveries which have been made during the last twenty years, the precious metal must be much more abundantly diffused than anyone could possibly have conceived.

The star of California had scarcely arisen ere it paled before that of Australia, and then followed British Columbia, in the immediate proximity of California. Whatever mines and placers may be found in the north or the south, in the wastes of Siberia, in the fields of Australia and New Zealand, or the sierras of California, or in the diamond regions of South Africa; wherever the fountain of the golden tide may gush forth, its streams will flow to the region where educated intellect has woven the boundless network of the useful and ornamental arts.

The fictitious El Dorado, so long sought for by the Spaniards, has been found at last in the nineteenth century, for we have veritable gold diggings in several localities, where the auriferous dust or nuggets may be exhumed by the sturdy labourer with his pick; and from the two regions situate on either side of the Pacific, the world has derived, since their discovery, additional wealth in gold of the aggregate value of fully £163,000,000 sterling beyond the gold previously in circulation. Of this sum, £85,000,000

has been produced in Australia, and £78,000,000 in California. This is merely the registered or officially recorded amount shipped to 1858; but we might almost add one-third more as a reasonable estimate for the quantities taken away unofficially, hoarded, or minted into coin in those countries.

Rail as we may at our climate, our toil and its poor reward here; grumble as we will at our taxation and political grievances, the condition of the meanest among us is, after all, preferable to the hard work, the precarious return, of the gambling chances of success of the gold-seeker. For instance, the average find of gold per head to the 100,000 persons employed in gold mining in Victoria in 1857 was but £122 per annum; and remember the difference of price for every article of consumption: bread, 1*s.* the 4lb. loaf; milk, 1*s.* a quart; eggs, 4*d.* a-piece; fowls, 6*s.* a-piece; meat, 7*d.* a lb.; and clothes, rent, and other essentials in proportion. Now the value of the yield of iron at the pit's mouth in the United Kingdom, a year or two ago, supposing it to have been equally divided among the persons engaged in working the mines, would have given to each so employed, £364, or about three times the individual income of the gold digger, showing at least how much more valuable iron is than gold in an industrial point of view.

The land we live in, with all its faults, has many special advantages which should not be lost sight of.

Labour, be it remembered, of some kind or other, is the lot of every human being, whether he toil with the hand or the brain; or endure that worst of all

toil, the labour of not knowing how to kill time—the irksomeness of being "used up," and seeking for something new under the sun.

But those who live in old countries and civilised lands, who have thousands ministering in some way or other for their every-day wants, are, after all, even if their lot be low, far happier than the slave to a thirst for gold, which demoralises and debases hundreds of heretofore moral, educated, and intelligent men.

A contemplation of the Book of Nature, and a consideration of bygone events, will inevitably inspire a trustful confidence in that Providence which has wrought so many marvels on our globe to fit it for man's habitation. That supreme Being who is guiding and directing man's intellect and industry into so many novel and wonderful, but useful, channels, will never cease to watch over man's happiness, will withhold no good thing from him.

Abraham Cowley, a rhymer of no mean fame, who flourished in the seventeenth century, and was the most popular poet of his time, thus anathematises gold :—

"A curse on him who found the ore!
A curse on him who digg'd the store!
A curse on him who did refine it!
A curse on him who first did coin it!"

But his maledictions are universally disregarded. After all, it is a necessary evil, and if our Colonies have got it in their streams, let it be sifted out; if in their rocks, let it be pounded out, "for money makes the mare to go." And as in "The Taming of the Shrew," it may in truth be said—

"Peace—thou know'st not Gold's effect."

Gold is a good thing when kept within proper limits: when it is the servant and not the master; when held as a power for doing good, and not as a god to be worshipped.

The poet Pollok alludes to the depraving influence of this gold-seeking :—

> " Gold, many hunted, sweat and bled for,
> Wak'd all the night, and labour'd all the day ;
> And what was this allurement, do'st thou ask ?
> A dust, dug from the bowels of the earth,
> Which, being cast into the fire came out
> A shining thing that fools admired, and called
> A god ! "

So true it is, that men will sacrifice home, health, comfort, friends, yea, and sometimes their very souls, to gain this glittering bauble.

As the mysterious stranger in the "Arabian Nights" said to Alie of Cairo, "This gold was preserved for thee by a talisman from ancient times;" so the rich auriferous treasures of the vast southern and northern continents would seem to have been kept hidden for the special behoof of our own busy and pushing generation.

We have added to our gold coinage in this country, in the last eighteen years, £85,500,000 sterling value; but it would be somewhat difficult to estimate what has been the quantity consumed in the same period in manufactures—for gold plate, jewellery, watches, and other purposes.

These figures are enough to startle the most inveterate sceptics, and disturb the quietude of incredulous minds, leaving reason powerless. The facilities and

simple modes in the present day of obtaining gold, seem, indeed, to realise the words of our great bard—

> "Put forth thy hand—
> Reach at the glorious gold."

But the mere discovery and accumulation of this gold is the least part of the benefit which the nations of the world have derived therefrom. It is the stimulus to Commerce; the new fields of industry opened up for honest labour; the profitable marts for British and foreign merchandise; the scientific improvements in steam navigation; in clipper sailing vessels; in railroads, canals, and telegraphs; in the navigation of rivers heretofore unknown; in the spread of civilisation into former desert regions; in the multiplication of the press; in the cities and towns which have risen up in desolate wastes, and are now peopled by thousands, gathered from various countries.

These are some among the numerous benefits which the world at large has derived from these powerful incentives to emigration.

Salt may seem a very insignificant product, owing to its present cheapness, but it is, nevertheless, a most important industry; the produce of the United Kingdom reaching 1,250,000 tons, worth nearly £700,000, and the declared value of that exported being nearly £500,000 sterling.

To the native of Africa, of India, and China, it is a necessary seasoning of his insipid vegetable food. The little negro in many districts enjoys a lump of salt as much as our boys do a sugar-stick; and there are, doubtless, those who can remember the time when

salt being 6*d*. a pound in this country, was much more prized and carefully used than it is at present.

I need not weary you with further details of mineral products; but there is one, the new metal aluminium, on which I must say a few words.

With the increasing scarcity of silver can nothing be done by the enterprising and intelligent metal workers, electrotypists, and others of Birmingham to bring this new metal into extended use, with all its advantages of cheapness, freedom from oxidation, &c.? It makes beautiful alloys. Would it not do for harness and plating purposes?

A Mr. Gerhard has announced a process by which he can produce aluminium for sale at 4*s*. per ounce. The main cost is the production of sodium, and this by the usual process adopted in France, he can obtain at a less cost than in that country, by reason of the materials for its production being cheaper here than there.

Information has reached me, which I believe to be reliable, to the effect that sodium can be manufactured at one-fourth its present cost, and if this be so, aluminium may be sold at about 1*s*. the ounce, an extraordinary difference as compared with silver, especially when we consider, too, the density of one metal as compared with the other. Mr. Gerhard's process differs from that of Deville, in using cryolite instead of an artificial double fluoride of aluminium. The latter is expensive to make; whilst cryolite is found in large masses in Greenland, and is imported into this country at about £10 a ton, or 1*d*. per lb. The price of aluminium in Paris,

wholesale, is £6 sterling per kilogramme, *i.e.*, 35 ounces.

Now let us pass on to a brief consideration of vegetable products, and here the range is so wide that it is difficult to know where to begin or what to select for notice. If we take the important section of vegetable oils, and oil seeds, &c., for crushing, we find that our imports of linseed in 1869 were upwards of 1,355,000 quarters, valued at £3,556,000. Palm oil was brought in from Africa to the value of £1,500,000 sterling; olive oil to £1,500,000; poppy and rape seeds, £760,000; while adding earth-nuts and kernels, cocoa nuts, castor oil, various oil seeds, and the oil-seed cakes used for fattening cattle and manuring land, the aggregate value is brought up to £11,000,000 sterling.

Of dyestuffs, the value imported in 1869 was—indigo, £3,194,113; of madder, munjeet, and garancine, £613,540; of sumach, £201,615; of safflower, £106,597; of orchella weed, £101,239; and of turmeric, £65,218; of saffron, £36,596.

The principal vegetable fibres consisted of cotton, of which we imported 545,000 tons. The exports of cotton goods, yarn, &c., in 1869, reached £66,500,000; while the home consumption of manufactured goods was £24,000,000. Then we imported 77,000 tons of flax, valued at £4,197,000, besides our own large home produce; and hemp, jute, and other foreign fibres and cordage reached us to the value of nearly £4,500,000 more. I could have much to say, were it possible to dilate on this important section, of cotton, plantain fibre, china grass, cocoa-nut coir,

kittool, ejoo, and piassaba, and the strong cordage, lashings, and such like, made from barks and grasses; of the delicate Dacca muslins and pine apple cambrics, and the coarse gunny baggings of India.

If we turn next to food supplies, to say nothing of the corn, grain, and flour of foreign produce, we imported rice and meal, &c., to the value of £2,000,000; sago worth £167,000; fruit, dry and green, valued at £2,750,000 sterling; even such an article as liquorice reaches £46,000 in value.

The dietetic articles for beverages have gone on increasing to an enormous extent, thus the value of the sugar imported, in 1857, was £15,500,000; of tea, 69,000,000 lbs., value £4,677,470. The coffee imported reached 59,000,000 lbs., 34,500,000 lbs. of which was consumed, of the value of £1,750,000 sterling. To this was added, for those who liked the mixture, 98,500 cwts. of foreign chicory root, valued at £49,500; the cocoa and chocolate imported was 7,300,000 lbs., the value of that entered for consumption being £270,000. Among the spices consumed were pepper, 3,656,000 lbs. (out of a total of 5,500,000 lbs. received) the value being £111,000; and 12,000 cwts. of ginger, valued at £42,000, and some others which I shall presently enumerate.

There was another article of large consumption, tobacco, valued at £4,000,000 sterling, which brings in a handsome revenue to the Exchequer, as do a few other foreign exciseable articles we now come to, namely, 6,601,690 gallons of wine, valued at £4,000,000; 1,300,000 gallons of brandy; 26,000 of geneva; 6,000 of unenumerated spirits; and 14,000 of sweetened

spirits; the whole valued at £2,000,000 when imported. This consumption is exclusive of gin, whisky, British brandy, and other home-distilled spirits and home-made wines, so that our consumption is, as the Yankees would say, "pretty considerable" in this line.

In the article of timber alone what a vast, what an unlimited supply, can be obtained, and is obtained, and of what endless varieties! Timber capable of furnishing materials for the requirements of every class of our population: calculated for the formation of the most stupendous works of utility, and the most minute works of luxury and ornament—that will serve alike for the construction of the noblest vessel that floats upon the ocean, and for the most minute ornament in a lady's boudoir; timber adapted for every use, where wood of any description is required, for ships of war and ships of peace—the frigate and the merchant-clipper, the yacht and the cargo-boat, ships of utility and ships of pleasure; timber for machinery, for the wheelwright, for the builder, timber adapted to railways, timber admirably fitted for the uses of the turner, gunstock maker, cabinetmaker and joiner, timber fitted for every purpose above the earth, upon the earth, and below the earth.

The quantity of wood of all kinds annually imported into Great Britain is not much less now than 16,000,000 of cubic feet; it is, therefore, a question of no small moment to know from whence we are to obtain such an enormous quantity in future years; which are the best woods, and from whence we may

expect to obtain them most economically, and with the least risk of failure in the supply.

The aggregate average quantity of timber of all sorts cut down yearly and used in the United Kingdom for ship and house building, wagons, carts, dock gates, and other marine works, props in mines, and all descriptions of implements, exceeds even the above large imports, being 2,500,000 loads or tons, which, at an average of 30*s*., exhibits the value as £3,750,000, irrespective of the imports of foreign and colonial timber, which, in 1857, exceeded 2,500,000 tons, and were valued at nearly £10,000,000 sterling. How much room is there still for the exercise of ingenuity and invention among our mechanics and artizans in all that relates to wood and its manufactures!

The dyewoods are too numerous to mention; of logwood alone we receive nearly 40,000 tons. Of the valonia, or large acorn cups, from Greece and Turkey, used for tanning, we import 24,000 tons a year, valued at £336,000.

Descending to the smaller products of the forest—reeds and canes and rattans—how various and important are these in a commercial point of view! Why we imported 12,000,000 of these in 1857, at the estimated value of £46,000 in the rough.

Few who look at sticks, probably, consider the immense outlay invested in them, and their varied uses. If such persons were but to make a tour of inspection over the different floors of one cane warehouse (Meyers and Davis) in Southwark Bridge Road, and see the large capital lying dormant, invested in these underlings of the forest, he would, indeed, be

surprised, as I was. There are to be found the valuable Malacca and partridge canes, and Penang lawyers; the Calcutta glossy canes, and the Singapore canes without gloss; the supplejacks or wild vines of the West Indies; the dogheads of China; the whangees of the East Indies; the worty crabs; the white and red dragon canes; the sapling oaks, with knobs for carvings; the ground and common rattans; the ash for single sticks, of which the firm is bound by contract to supply large numbers every month to the Tower. There are bamboos and other canes for splitting; used for bonnets and for chair-seats, for whipping naughty boys, for cane-brooms, and for the ribs of umbrellas, in sets of eight. There they are, ranged in huge piles and bundles of every shape, size, length, and texture, enough, one would suppose, to stock the whole world.

A traveller, among other narrations of wonders of foreign parts, declared he knew of a cane a mile long. The company looked incredulous, and it was quite evident they were not prepared to swallow it, even if it should have been a sugar-cane. "Pray, what kind of a cane was it?" asked a gentleman, sneeringly; "probably a hurri-cane."

But sceptical as persons may be on this head, these long, twining stems do extend enormous lengths, in the tropics, running along the ground, and interlacing trees. Part of one was shown at the Paris Exhibition in 1855, which is stated, in the official catalogue of the island of Ceylon, to have extended for more than a mile.

Potash is collected on a large scale only in those

countries where wood is the principal fuel; to produce it the ashes are collected. When there is a sufficient quantity, they are mixed with water in a large vat, until all the potash contained in them is dissolved in the water. This water, containing the potash in solution, is boiled down in cast iron pots—hence the name potash—until the water has evaporated, leaving the potash in a solid form.

This manufacture is carried on largely in some parts of the United States and in Canada. And to give you an idea of the extent of this manufacture, the quantity of wood ashes imported into Great Britain averages about 8,000 tons per annum. It is brought over in barrels, weighing about 5 cwts. each, and is chiefly used in the manufacture of alum, flint glass, prussiate of potash, and soft soap. When the ashes are heated in a furnace they become pearly white, and are then called pearlash.

If we turn to spices and condiments, we find that 100 or 200 tons of cinnamon bark reach us, exclusively from Ceylon; about half as much cassia bark, besides cassia buds; small parcels of clove bark, about 120 tons of nutmegs, a few tons of mace, the arillus or envelope of the nutmeg; small quantities of canella bark, about 300 tons of cloves, and more than 1,000 tons of pimento or allspice from Jamaica, and a few hundredweights of the vanilla pod, constitute the chief spices furnished.

Were we to go into a special consideration of the barks and roots of trees, we should find how valuable these are for various medicinal and manufacturing purposes.

The Peruvian bark, or cinchona, furnishes the

important alkaloid quinine. Sarsaparilla has come into enormous use, although the Americans seem to go-ahead in this as in other enterprises, for the late Dr. Townsend, the original sarsaparilla man, whose advertisements stare you in the face everywhere, built himself a palatial residence in New York, with a chapel, gymnasium, picture gallery, and offices, at a cost of over £40,000 out of his profits. We pay upwards of £3,000,000 for barks of various kinds for tanning purposes, £1,000,000 more for other tanning substances and heavy dyewoods, besides about another £250,000 for various extracts of tannin, such as gambier, cutch, and kino. But we paid in 1857, £300,000 for gums and resins; and another £300,000 for those very important elastic gums, gutta-percha and caoutchouc, or india-rubber.

Lastly, we paid for doctor's stuffs, drugs derived from the vegetable kingdom, opium, scammony, sarsaparilla, sulphate of quinine, rhubarb, senna, &c., nearly £500,000.

And now, having shown you by an abstract the extent of our Foreign Commerce, and our dependence upon distant countries; having carried you over the range of our principal mineral products, and their useful applications; having stated to you the quantity and value of some at least of the many things with which you are fed, clothed, sheltered, and physicked; having, I fear, wearied you with the interminable details of facts and figures necessarily incident to such a subject, it is high time to release you, which I do by thanking you for the polite attention you have accorded to these desultory and dry details.

LECTURE IV.

THE INDUSTRIAL AND MANUFACTURING USES OF SHELLS.*

Shells, from their variety of structure and colour, and their singular beauty, have always formed a fruitful theme of description for the writer and the poet. The works of most of our best authors teem with lovely passages, many of which must occur to the memory of any general reader.

> "Their exquisite, fragile, and beautiful forms,
> Are nursed by the ocean and rocked by the storms."

By young and old, savage and civilised, shells are alike admired and coveted, either for personal decoration, for the cabinet of the collector and naturalist, or as simple ornaments in a room.

Unfortunately I am shut out from the poetical aspect of the subject—the title of my Lecture restricts me to plain matters of fact, and I must confine myself,

* A Lecture originally delivered at the South Kensington Museum in 1858, and subsequently at one or two other institutions.

My friend, Dr. J. E. Gray, F.R.S., having been announced to lecture for the Department of Science and Art, and being prevented by illness, suggested that, as I had paid some attention to the subject in collecting and arranging objects made from shells at the South Kensington Museum and for the British Museum, I should take his place. The statistics and information given have, however, been corrected to the present time.

therefore, chiefly to the applications of shells for personal decoration and manufacturing purposes.

This, be it remembered, is essentially a practical and utilitarian age. Not that we by any means neglect the pursuit of intellectual improvement, or fail to appreciate the ornamental and elegant; but to everything the practical test is now applied. What is it good for? What can be done with it? What can be made of it? What will it realise? These are the invariable questions now.

Thus I am brought down to the low level of the mere industrial and commercial uses of shells, apart from their distribution, formation, beauty, and variety of shape and colour. I am even debarred from alluding to the curious *inhabitants* of those marine dwellings which are offered for sale to terrestrial purchasers, who ruthlessly destroy their original beauty and singular structure, and convert them frequently to very ignoble purposes.

Like the lawyer in the fable, I may swallow the oyster and hand you, my clients, the shells.

But I hope, at least, to be able with the shells to afford you some slight statistical and general descriptive information, which may furnish subject for after reflection and at least serve to show that the uses to which shells are applied is more extensive than is generally supposed; that the trade is growing year by year into greater importance; and that there is ample scope yet for its extension with profit and advantage, alike to the merchant and importer, to the manufacturer and vendor, and to the general public who are the purchasers.

In considering the manufacturing and useful applications of shells, they may be conveniently ranged under the following groups:—1. The nacreous shells used for making pearl buttons and other useful and ornamental articles. 2. The pearly and iridescent shells, for ornamenting papier-mâché work, making cardcases, folios, jewel cases, &c. 3. Various small shells used for making shell flowers and different fancy articles of grouped shells, and for ladies' bracelets, headdresses, &c. 4. The shells used for carving cameos to set in brooches, bracelets, necklaces, scarf pins, coat studs and sleeve links, and other articles of personal decoration. 5. Shells used for spoons, drinking vessels, lamps, handles for knives, and other purposes of domestic economy; for snuff boxes, pipes and such like curiosities. 6. For making the purest kind of lime when calcined; for manure, in the form of shell-sand and shell marl; and for making pottery-ware and glaze or enamel, when crushed. 7. Shells are largely used for small monetary payments in North America, India and Africa, and also as counters in games of chance. Lastly, they serve as studies of design, form and colour for the sculptor, painter, and art manufacturer.

There are other uses besides the foregoing, but at least these are the principal ones.

It will not be possible to adhere very closely to this arbitrary arrangement, owing to the several uses to which some shells are applied.

Before entering upon the uses of shells, it will be necessary that I should explain to you their composition, or the nature of the material of which they are

formed, so that you may be the better able to understand their applicability to particular purposes, and the mode of working them up.

I presume I need not do more than state briefly (what, no doubt, is generally known to you) that the principal types of shells are the univalve, of which the periwinkle and the cowry are types; the bivalve, represented by the scallop, mussel, or oyster; and the multivalve, of which the common barnacle is an example.

All shells, how much soever they may differ from one another in structure, agree in containing carbonate of lime or chalk as their only earthy constituent; and an animal substance, nearly resembling, if not identical with, horn or membrane, as their consolidating or agglutinating ingredient. There is a class of shells, comprising most of the univalves, which are harder than other shells; when broken they present thick, parallel layers, the layers themselves having usually a finely fibrous structure at right angles to the external surface. These fibres may often be seen to be nothing more than the transverse section of their transparent parallel lamellæ, which, when viewed on their broad surfaces, often exhibit the usual natural joints of calcareous spar. When such a fracture is viewed by the naked eye, it has a good deal the appearance of porcelain—whence their name of porcellaneous shells.

Another class of shells is the nacreous, so called from the varying and iridescent colours that they exhibit, resembling those of nacre, or mother of pearl, this very substance being, indeed, only a part of a nacreous shell. When the calcareous matter has been

removed from these shells, there remains a series of flexible, membraneous or semi-gelatinous lamellæ, lying parallel to one another and representing the form of the entire shell. These lamellæ have sometimes a distinctly fibrous structure parallel to the surface of the shell, and though quite flexible while moist, they shrivel on drying, and become hard like horn—a substance to which they bear the greatest possible analogy.

The nacreous shells, therefore, are always very finely lamellar in structure, and are represented by some as composed of alternate layers of membrane and carbonate of lime; but the more probable opinion is, that the calcareous matter is intimately mixed with the membrane, rather than distinct from it.

These shells increase in size, in order to accommodate themselves to the growth of the animal, by the deposition of new and larger layers from within, and hence the external surface is covered by concentric furrows or wrinkles, marking the outer margin of each successive layer.

The well-known mother of pearl shell is the most important of the commercial shells, from its extended range, numerous applications, and general use. The varieties of pearl buttons, studs, and links alone are innumerable, and of every shape and device. This shell is also worked up into ladies' waist buckles, brooches, paper cutters and book markers, pen holders, and a host of other fancy articles.

The beautiful tints of mother of pearl are dependent upon its lamellar structure, the surface being covered with minute grooves, cells, or depressions, so

small that upwards of 3,000 are contained in an inch, which decompose and reflect the light. The kinds of pearly shell chiefly used for inlaying are three—mother of pearl, which is known by its clear white surface; aurora shell, which can readily be known by its wrinkled appearance and various prismatic colours, obtained from different species of *Haliotis*; and what is commercially known as the green snail, which can be told by its glistening colours of light and dark green, a soft yellow and a bright and beautiful pink, blended together.

We import annually 1,500 to 2,000 tons of mother of pearl shells, worth, in the aggregate, £80,000 to £90,000. There are five or six principal commercial varieties of this shell, known as the white edge, that most esteemed, brought from Manila; the yellow edge and pure white, from Egypt, and South America; South Sea Island black, and West Australian.

	Prices, Jan. 1862, per ton.	Prices, Jan. 1872, per ton.
Manila	£80 to 90	£170 to 190
Bombay	20 to 50	58 to 167
Panama and Tahiti	40 to 50	22 to 44
Australian	140 to 150	150 to 235

But much depends upon quality. For they come in bulk, without any attention being paid to the sorting or keeping the dead and grubby or worm-eaten (of which there is always a greater proportion among the larger shells) separate. The medium and small sorts, always being the cleanest, bring higher rates in comparison with the larger kinds; they should also be of

a bold, fine, good, clean white colour and substance, and not broken.

These shells are again subdivided according to size and quality. The smallest are the South American, weighing about $\frac{1}{2}$ lb. per shell—that is one valve, for they never come in pairs. The Bombay and Egyptian weigh about $\frac{3}{4}$ lb.; the South Sea black 1 lb., while the largest are the Australian and Manila, weighing on an average $1\frac{1}{4}$ lbs.

The price of these shells, it will be seen, has much advanced of late years, and the imports have not increased in proportion to the extent of the consumption and demand. The advance has been from 40 to 50 per cent. generally, and in some cases much more. The black, or South Sea shell, which was formerly little valued, and of which it is said there are many tons buried in the streets of Birmingham and Sheffield, has also risen in price, since the change of fashion, which has brought the large dark pearl buttons into use for ladies' cloaks and paletôts, and for gentlemen's vests and shooting coats. These buttons are called "smoked pearl" by some dealers, but from the same shells white buttons are also made, when the part nearest "the knot" or muscular impression is used.

The extreme edge or "skirt" serves to form the black or dark buttons. To show how extensive is the trade I may state that one firm alone at Birmingham makes nearly half a million gross of pearl buttons annually.

Mother of pearl was formerly more extensively used than at present in the manufacture of "scales," as they are technically termed, for the handles of dessert

and fancy knives and forks, and penknives. These scales are the two flat pieces rivetted to a central plate of the haft or handle. The only nacreous shells possessing sufficient thickness for Sheffield purposes are those received from Manila and Singapore. The smaller shells from Bombay, Panama, and other places are used chiefly in Birmingham, and are there worked into buttons and counters and paper cutters, or else used for inlaying purposes in papier mâché work, ladies' portmonnaies, cardcases, working implements, book covers, and such like. Small fancy devices for inlaying are punched out of the shell. Button blanks are cut out with the annular or crown saw fixed upon a lathe mandril. Here is a shell which has been operated on for the purpose to drill out the blanks, these are then ground and cleaned. Next they are turned into a pattern; after that "fanceyed" or an ornament put on the face; then the holes are drilled by which it has to be attached with thread to the garment, and, lastly, the button is polished. They are then sorted and mounted on cards of a gross each, which sell at from 1*s*. 6*d*. to 8*s*. I should state that the blanks are split into two or more sections according to the thickness of the button required. Pearl buttons are made of all sizes, from the brobdignag ones for coats, costing 2*s*. or 3*s*. each, to the tiny button for mere ornament.

The superior articles made from this shell are comparatively dear, in consequence of the large amount of labour spent in reducing or grinding the shell to any given size or shape, a process which eventually will, no doubt, be rendered more facile by the introduction of machinery.

An extensive manufacture is carried on at Jerusalem of small articles carved out of mother of pearl and on the shells themselves. We often meet with these and with crucifixes, wafer boxes, beads, &c., which are sent in large quantities to the Catholic countries of South America. The carving on some of these "pilgrim shells," as they are termed, is often very good.

Recently attempts have been made to bring mother of pearl shells, when elaborately carved, into use as dessert plates at the tables of the wealthy. The Chinese carve very beautifully on this material. The card counters, markers, &c., from China must be familiar to most.

The Dyaks of Borneo wear pearl shells, polished, in front of their corslets and shields.

At Manila they are set in a wooden frame-work of small squares, forming windows or shutters, which move on slides in the verandahs. They are strong and durable, but not transparent. The Chinese, however, employ a more thin and semi-opaque shell, popularly known as the paper-oyster shell, for a like purpose in glazing the windows of their junks and houses. These are the *Placuna papyracea*, *Anomia*, and other shells.

Worthy of mention also is the cathedral and some of the churches of Panama; the upper portions being studded with pearl shells give them a brilliant and sparkling appearance.

Even the small true-pearl oyster shells from the shores of Ceylon, which were formerly deemed worthless, have lately come into limited use for the nacreous substance which they furnish, for although thin, the shell serves for inlaying, and other like purposes.

The mention of this shell naturally leads me to a product, in which ladies are sure to feel an interest; the gems obtained from the pearl oyster—a subject to do full justice to which would alone occupy an entire lecture—I must not, however, pass pearls over without some mention, because they belong as it were to the topic under notice.

The value of the pearls imported into this country varies greatly; in the five years ending with 1858, it averaged but £55,000; in the four years ending with 1862, the import of pearls reached nearly £100,000 per annum; since then the annual value of those imported has seldom reached £50,000 a year.

No doubt the splendid necklace of thirty-six fine pearls presented to his bride by Prince Frederick of Prussia, was the admiration and envy of many when exhibited for public inspection.

The value of the pearls obtained in different quarters of the world is considerable. Lieutenant Wellsted, in his travels in Arabia, tells us that the value of the pearls collected in the Persian Gulf fisheries is estimated at £400,000, and they are said to form there the principal source of revenue of the Imaum of Muscat.

The finest pearls are procured from Ceylon and the Gulf of Persia. Those from the West Indies, California, and Otaheite, &c., are less perfect, and still less so most of those from the rivers of Europe. But, even among those, and in particular the pearls found at Celle and in Livonia, there are a certain number of uncommon beauty and perfection.

Pearls are also obtained in the Gulf of Mexico, and Bay of Panama, and in the Gulf of Maanar, between

the Island of Ceylon and the Continent of India, yielding occasionally a large revenue to the Ceylon Government for the right of fishing for the oysters.

The pearl is not valued for its silvery whiteness at Ceylon, but for its golden hue, or rose colour. Besides these three colours, pearls are found of a delicate blue tint, and some have a yellow, and others a silvery hue. Mr. Beresford Hope owns the largest known pearl; it weighs three ounces, being two inches long, and four-and-a-half inches in circumference. The formation of pearls is now fully understood to be the deposition of shelly matter by the animal in an abnormal or unnatural situation.

Pearls are obtained in several kinds of shells, and like the shell itself, are always formed of a large number of concentric layers, and according to the position they occupy, partake of the character of the shell near which they are found.

Thus, the pearls in the centre of the nacreous shells, are of the usually pearly structure of those shells, while the pearl found on or near the outer coat of the *Pinna* are of the same brown colour, and prismatic texture, as that part of the shell, and those found on that part of the mussel shells are of a blueish hue. The dark-coloured pearls are little esteemed; in general they are procured from the black mother of pearl.

It was formerly believed that pearls were only obtained from bivalve shells, and it was, therefore, difficult to understand what shell it was that yielded the pink pearl, for no known bivalve has such a coloured inner surface. It is now ascertained that

the pink pearl is the production of one of the porcellaneous or chank shells, the *Turbinella scolymus*.

All doubt on this head is set at rest by a specimen of this shell in the British Museum, where a fine large pink pearl has been caught, and embedded in the shell near its aperture, just as it was about to escape. The pearl is exactly like the internal surface of that shell. [I had occasion to speak largely on pearls, in a Lecture delivered before the Society of Arts, London, January 19, 1870, on the Pearl, Coral, and Amber Fisheries,* but time will not allow me to dwell upon the subject now.]

I pass on to speak of the pearly and iridescent shells, which are used for inlaying and ornamental work.

The green snail of the dealers, the *Turbo olearius*, is very largely used for ornamental purposes. Slices of this shell, ground down to a thin surface, are employed for covering or inlaying various articles, such as—small stamp cases, little tablet covers, fancy boxes, baskets with metallic handles; buttons, earrings, and other articles are made of it, very pretty ornamental stands, which open with a spring, enclosing scent-bottles, or cigar holders, and such like. Fine large shells of this kind formed the drinking goblets of the Scandinavian monarchs, and are often still met with, very elegantly mounted and set with jewels.

Another shell of this genus, the Turk's cap (*Turbo sarmaticus*), from the West Coast of Africa, is used for smaller articles, caskets, scent-bottles, brooches, &c.

The ear shell of different species, principally the green kind, *Haliotis iris*, and the common British,

* "Journal of the Society of Arts," vol. xviii, p. 173.

Haliotis tuberculata, and some Japan and Californian species, are much used, from their brilliant play of colour, ground down for inlaying in papier mâché work, as well as for buttons, studs, links, buckles, and earrings. Among other handsome species of ear shell which are polished and used are, *Haliotis rufescens*, *Haliotis splendens*, and *Haliotis cracherodii*.

In the papier mâché manufacture paper is first steeped in oil, and dried in an oven; then coated with black varnish, and pieces of pearl embedded, when it is again placed in the oven. The process is repeated several times; it is then pencilled with a resist; afterwards rubbed with pumice-stone; then etched out with nitric-acid, and flowers and patterns are painted. The colours are rendered almost indelible by a second coat of refined white varnish.

Having dealt with this section, I am now brought to a large collection of small shells entering into trade use, for making shell flowers and different articles of grouped shells on boxes, &c. A great proportion of these are British shells, collected freely on the beach in many parts of our coasts, and most are sold by dealers under the name of grotto shells.

The shells chiefly used for imitation flowers in forming tulips, moss-roses, passion flowers, anemones, hops, &c., are parts of the valves of barnacles (*Lepas anatifera*), *Dentalium*, *Olivia oryza*, *Marginella*, *Strigella pisiformis*, *Pholas dactylus* and *papyracea*, *Tellinas*, *Cardium*, and others. It requires only taste in the selection and adaptation of suitable shells or parts of shells to form the petals of the flowers and colour applied to the shell where necessary.

Mr. Mayhew, in his "London Labour and the London Poor," tells us that there are about a million of the commoner sorts of shells bought by the London street sellers, at 3*s.* the gross. They are retailed at 1*d.* a-piece, or 12*s.* the gross, when sold separately.. A large proportion, as is the case with many articles of taste or curiosity rather than of usefulness, being sold by the London street folk on country rounds; some of these rounds stretch half way to Bristol, or to Liverpool.

An important trade in shells, although purely local, is the fishery off the coast of Coromandel, and other parts of the Indian seas, for the Chank shell, as it is termed in the East, the *Turbinella pyrum.*

These heavy massive shells, species of which from their form have received the specific names of pear and turnip shells, are often used as trumpets, and as oil vessels or lamps in the Indian temples, being ornamentally carved and mounted in metal for this purpose. Specimens may be seen at the India Museum, Whitehall.

The manufacture of rings for the arms and ancles from these Chank shells, is still almost confined to Dacca; the shells are sawn across for this purpose by semicircular saws, the hands and toes being both actively employed in the operation. The introduction of circular saws has been attempted by some European gentlemen, but steadily resisted by the natives, despite their obvious advantages.

In illustration of the rudeness of the operations resorted to for glazing or smoothing linen, &c., in Africa, a shell is used where we employ a mangle. I may also mention the practice of the East Indians, who use the Chank and other solid and heavy shells to

smooth the paper made in Nepaul, and the muslins and cloths in other districts.

For the purpose of giving a fine glossy appearance to sarongs and other cloths, the natives of Sumatra also use a shell called kurup, in the aperture of which they insert one end of a piece of split nebong, which is very pliant and elastic; the other end is inserted into a cross piece of wood in the ceiling of the hut, and the nebong being cut like a bow, the pressure on the cloth is heavy. A person continues rubbing the cloth for several hours, until it has acquired a beautiful polish, like glazing.

I pass on, now, to speak of the shells used for carving cameos, and those employed to form articles of personal decoration.

Of the quantities imported for this purpose here I can obtain no reliable details. The shells come over in bags, and every now and then the City brokers announce a sale of bull's mouth, helmet shells, queen conchs, &c., but no aggregate records are kept of the numbers.

To show, however, the extent of the trade in shells, here are the particulars of the sales advertised on one day (October 10th, 1871), by various City brokers:—

By Lewis and Peat—

275 cases Bombay M.O.P.*
48 „ Egyptian „
6 „ Gambia „
232 „ Panama „
45 „ of Cowries
81 packages Fancy Shells
195 cases Japan Ear Shells.

* The trade abbreviation for mother of pearl.

By Ellis and Hale—

140 cases and 6 casks of M.O.P. from Freemantle.
8 cases and 27 serons M.O.P. Bombay.
211 cases of Cowries.
24 tons of Japan Ear Shells.

By Price, Hickman and Co.—

18 cases Bombay M.O.P.

By Bowyer and Bartlett—

41 cases M.O.P.
6,000 Conch Shells.
1,400 Helmet Shells.

By Brooks and Faith—

84 baskets, 13 bags, and 10,000 loose Green Snail.
230 packages and 10 tons of loose Japan Ear Shells.
12,000 Turbos.

By Donald Gray and Sons—

39 cases Manilla and 51 cases Bombay M.O.P.
1 case Red Shank Shells.

By John Griffin and Son—

194 cases Bombay M.O.P.
381 bags Maldive Cowries.
5 tons Japan Green Ear.

The word *cameo*, derived from an Arab word, signifying bas-relief, was originally restricted to hard stones, such as onyx, sardonyx, &c., engraved in relief; but the name has been extended to gems cut on shell, lava, and other substances. Shell cameos, some years ago, were a good deal in fashion, and even now a well-executed, artistic Roman shell cameo is an elegant work of art. Genoa and Rome are the seats of the best work, although many common ones are cut in France.

In Rome there are about eighty shell cameo cutters, and in Genoa thirty, some of whom also carve on coral.

The ordinary mode of procedure in cutting shell cameos is to fix the piece of shell intended to be carved upon a block of wood about three inches in diameter, or of a convenient size to be grasped firmly in the hand. The contour of the subject to be carved is sketched out in pencil, and this pencil mark is followed with a scratch point. Having removed the surrounding white substance by means of files and gravers, you proceed to develope the figure by the use of smaller tools.

In cameos the central layer forms the body of the relief, the inner layer being the ground, and the outer the third or superficial colour, which is sometimes used to give a varied appearance to the surface of the figure. In a paper read by Dr. J. E. Gray, F.R.S., before the Society of Arts, some years ago, he thus speaks of shell cameos :—

The cameo cutter selects from the shells which have the three layers :—1. Those which have the layers strongly adherent together, for if they separate, his labour is lost. 2. Those in which the middle layer is thick. 3. Those in which the inner layer is of the colour suited to his purpose.

The kinds now employed, and which experience has taught him are best for his purposes are :—1. The bull's mouth (*Cassis rufa*), which has a red inner coat, or what is called a *sardonyx* ground. 2. The black helmet (*Cassis madagascarensis*), which has a blackish inner coat, or what is called an *onyx* ground. 3. The horned

helmet (*Cassis cornutum*), with a yellow ground; and 4. The queen conch (*Strombus gigas*), with a pink ground. The bull's mouth and the black helmet are the best shells for the purpose, as the horned helmet is apt to separate from the ground, or to "double," as the workmen call it; and the last, the queen conch, has the two colours seldom distinctly marked from each other, and the pink of the ground flies by exposure to the light. The red colour of the bull's mouth only extends a small distance in the mouth of the shell, becoming paler as it proceeds backward, as may be observed by the pale side generally to be seen in such red-grounded cameos. Hence the bull's mouth affords only a single cameo large enough for a brooch, and several small pieces for shirt studs, while the black helmet yields on an average about five brooches and several stud pieces. The queen conch yields only a single good piece. The bull's mouth shells are brought from India and Ceylon; the black helmets from the West Indies; and all are supplied through the London market.

Unset cameos, of the value of about £5,000, are yearly received from France, to be mounted at Birmingham; and are either sent back to France, or exported to America and the Colonies. A quarter of a century ago the value of the shell cameos cut in Paris was estimated at £40,000. The trade in these, although still extensive, has lost much of its interest, for neither in France or England are brooches, earrings, scarf pins, &c., of shell cameos so much appreciated as they formerly were. Fashion and novelty lead to great changes in this as in other manufactures.

The next sub-division—the use of shells for spoons, drinking vessels, lamps, handles for knives, and other purposes of domestic economy or ordinary utility—takes in a very wide range.

The valves of the *Anodonta escula* are used as skimmers in Brazil, and the shells of the *Ampullaria* serve to dip up the caoutchouc gum. The Africans on the West Coast make much use of the large shells of the *Achatina* snail, shaped into spoons.

Shells are still used for scoops, spoons, &c. In many countries the melon shell and others are employed to bale out boats; to hold oil and a wick, suspended as lamps; to skim milk; and, from some unexplained custom, shells seem a necessary ornament or appendage in the window of the milk shop or dairy, in the metropolis.

The less civilised inhabitant of coasts frequently forms his knife, his hunting spear, and his fish-hook of hard shell. In the latter instance it serves the secondary purpose of a glittering bait. The Chinese grind shells to powder, and use this powder in the way we do flock on paper-hangings.

A small white bivalve shell (called Irego by the natives of Western Australia), is used for sharpening their spears when they cannot procure glass.

The Friendly Islander wears the scarce orange cowry as a mark of chieftainship, and the New Zealander polishes the *Elenchus* into an ear ornament more brilliant than the "pearl ear-drop" of classical or modern times. One of the most beautiful substances in nature is the shell-opal, formed of the remains of the ammonite.

In Caldera, Chile, a kind of scallop shell very finely marked with a delicate pink, is frequently used by the refined portion of the population, as a little dish to hold soap on the toilet table.

Murex colosseus is used as a trumpet, and large species of the genus *Buccinum* are still used by Italian herdsmen in directing the movements of their cattle, and a variety of sonorous sounds may thus be readily produced. They are also often used in North Wales by the farmers to call their labourers, and in Lithuania and Muscovy by the herdsman to assemble his cattle. In the West Indies the common fountain shell, a species of *Strombus*, is also used to call in the negroes from the sugar-cane fields—the interval of "shell-blow," as it is termed, being the dinner hour. In the East Indies shells are used for the same purpose by the Brahmin priests and others; and the great *Triton* is so employed by the Pacific Islanders.

Scallop shells (*Pecten*) were formerly worn by pilgrims, on their hat or the cape of their coat, as a mark of their having crossed the sea for the purpose of paying their devotions at the holy shrine in Palestine; in commemoration of which, they are still preserved in the armorial bearings of many families of distinction, whose ancestors had performed that ceremony. From its use by cooks now, this shell has given the name to "scalloped" oysters. In early times, when plates and drinking vessels were not so plentiful as they are now, the concave, or hollow valve of the scallop served as a cup, and the flat valve for a plate. The idea has even been carried out by our pottery manufacturers, and plates and dishes have been

moulded after the forms of bivalve shells. I have seen reticules, needle books, pincushions, and other articles made with the scallop shell.

Of late, among the curious uses to which the *Turbo* and some other shells have been applied here is for pipe bowls.

Now, uncivilised tribes have been before us in this application also; for Mr. Adams, in his "Voyage of the Samarang," states, that among the Bashee group, and more particularly on the island of Ibayat, the natives form very elegant and commodious pipes from different species of shells, the columella and septa of the convolutions being broken down, and a short ebony stem inserted into a hole at the apex of the spire. Some are formed from *Mitra papalis* and *Mitra episcopalis*, others from *Cerithium* and *Terebra*.

The *Mytilus* or mussel shell has a few applications—when polished, they are made into pretty needle books and scent-bottle holders. They are mounted on marble as paper-weights, and are used by artists as the receptacle for gold and silver paint. The New Zealanders employ mussel shells as tweezers to eradicate the hair from their face. Some of the cockle shells are made into pretty pincushions, and the shell-flower maker uses them to form the hop and other imitations. Common, cheap pincushions are made with the whelk, and many other shells.

The shells of the cowry family next claim our attention, a most extensive genus, distinguished, if not for their elegance of form, yet for beauty of tints and richness of polish. This polish is preserved by the animal, while alive, enveloping the shell in the

mantle or membraneous fold. They are in general smooth, glossy shells of great brilliancy of colour, and elegantly marked with dots, zig zag lines, undulations, stripes, and so forth. They are all, excepting the small British cowry, natives of the seas of warm climates. Many of them are very highly prized by collectors, and several are turned to use for ornamental purposes.

The species of cowries principally used for bracelets and links, or brooches and small charms, are *C. undata*, *C. felina*, *C. asillus*, *C. ziczac*, *C. cribarea*, and *C. reticulata*. I have seen cameos traced on the back of the blue-back cowry (*Cyprea moneta*), and they then make very neat bracelets. Cowries are sometimes used for making an enamel for clock faces and a glaze for plates.

Cowries are largely dealt in for exchange purposes and are shipped in quantities to West Africa. They are chosen for their bright enamel, small, even size, and not being mixed with spurious shells. Maldive cowries fetch at the present time (January, 1872) 12*s.* to 35*s.* the cwt., Dacca and Cuttack cowries, 6*s.* to 22*s.* 6*d.* the cwt., but common blue and dead shells, that is those with no gloss or enamel, are only worth 3*s.* 6*d.* to 15*s.* the cwt.

One of the most common and at the same time one of the most beautiful species, the tiger cowry, is frequently cut for snuff-boxes, made into ink holders, and ring stands, salt cellars, &c., and has frequently the Lord's Prayer, or sentences, engraved on it. I have seen them mounted as punch ladles and spoon bowls, and made into whistles and other fancy articles.

They are often shaped into grotesque imitations of animals.

The skin jacket worn by some of the Bornean tribes in war is ornamented with small shells placed over one another, like scales or links in a coat of armour. The Dyaks stick small white money-cowries in the eye-sockets of the skulls of their enemies, which they keep; they look like a closed eye. In India these shells are much used to ornament the trappings of horses and elephants, and many of these cowry bands may be seen in the India Museum.

Another shell requires to be mentioned for its various uses, popularly known as the Dutchman's cockle, a large species of clam, the *Tridacna gigas* of conchologists. It is the largest and heaviest shell known, the pair of valves have been found in some instances to weigh 500 lbs.

In its full size it has a byssus like a cable, with which it anchors itself, and which must be cut with an axe. The large valves of these shells are principally used for *bénitiers* in Catholic churches, and for fountain basins in gardens. I have seen the smaller shells mounted as salt cellars, pincushions, and candlestick holders. Cameos have also been carved from them, but their dead white wants a relief of colour. The hill Dyaks of Borneo wear broad armlets made of this shell, which, when polished by length of use, resemble ivory, but never acquire its yellow tinge, always remaining of the purest white colour. Two of these valued shell-bracelets on each arm are the favourite number with the women.

The pearly nautilus is sometimes used as a drinking

cup, and I have also seen it mounted as a stand for flowers on the mantelpiece or table.

Calcined shells furnish the purest lime, and it is this which, under the name of chunam, is so largely used in the East as an ingredient, with the areca nut and betel leaf masticated.

For the purposes of the agriculturist shell-sand and shell marl, when obtainable, are highly valuable as fertilisers; and crushed shells enter into use for covering the paths in our parks and the walks of gardens; for making fine pottery, and other purposes.

Lastly, the uses of shells as studies of design, form, and colour to the sculptor, painter, architect, and art manufacturer, may be seen in various parts of the South Kensington Museum.

The subject has been often alluded to in the "Art Journal;" and some years ago I called attention to it myself in the columns of the "Building News."

Lamarck long ago recommended to the attentive study of the architect the extreme diversity of the protuberant parts on the surface of shells, as well as the regularity and elegance of their distribution. There is no possible form of which Nature does not offer examples. Architecture would find in many of the species of the genus *Cerithium*, even to those of *Pleurotomes* and spirals, a choice of models for the adornment of columns, and these models would be found very worthy of being employed.

Shells were the favourite objects of ornamentation of the older wood carvers, as evidenced in the fire-places of many ancient mansions. The famous garoon

pattern, so much used formerly by silversmiths, is said to be derived from the edge of the trumpet shell (*Triton emorale*), which is called the garoon shell.

There are many other industrial uses of shells, but those I have enumerated may be considered the principal ones. I could have wished to have brought before you a larger and more varied collection of articles made from shells; but many of these are somewhat costly, and brittle, when carried to a distance, and probably many are familiar to you in the shops.

The aggregate value of the imports of foreign shells, in the last few years, may be taken at £250,000. It is somewhat difficult to arrive at any correct estimate on this subject, because shells are scarcely particularised in the Board of Trade returns. Classified under the head of raw materials which come in "duty free" for the use of manufacturers, the officials are very indifferent as to the nature of the imports; and thus we have no account of the rough cameo shells, the snail and ear shells, the Murices, and others which are received in large quantities. When shells were subject to an import duty, varying from 5 to 20 per cent., it was necessary that the entries should be more specifically detailed.

Large quantities of shells, which are used for different manufacturing purposes, come in under the broad, general heading of "specimens of natural history." The only specific mention of shells in the Parliamentary trade returns are mother of pearl, cowries, and cameos unset, besides pearls,—the well-known and valued product of the pearl-oyster.

The imports and value, as far as officially stated, in 1870 were :—

Mother of Pearl, 26,197 cwts................	£76,489
Cowries, 6,118 cwts	6,347
Cameos, not set	3,445
Miscellaneous Shells for Collectors, Dealers and Manufacturers, about	14,000
Pearls	16,675
	£116,956

These figures were much below the average. But their use is not restricted to this country, shells are largely employed for manufacturing purposes in China and India, in France, Italy, Germany, and other parts of the Continent of Europe, and also in North America, so that the subject we have been considering takes larger proportions than at first sight would appear.

LECTURE V.

THE PROGRESS OF SCIENCE IN THE NINETEENTH CENTURY.*

THE subject which I have undertaken to discuss may, at the first glance, appear dry and uninviting to a general audience, and yet, if viewed in its several relations to the Arts and Manufactures, its bearings upon Civilisation and Commerce, upon our every-day comforts and the progress of the world at large, no topic is more comprehensive and interesting, or can be more important, or more worthy of our careful consideration.

Science, to the scientific inquirer, to the thoughtful investigator, is full of beautiful results, of progressive discoveries, and of attractive features. There is even much of romantic interest interwoven with the history of the rise and progress of those wonderful inventions which have now attained to such beauty, simplicity, and perfection, and are looked upon by men of the present day without either astonishment or surprise.

What marvels have been achieved in the brief period of sixty years! within the lifetime of some who hear me; and what further wonderful improvements may not be carried out before the close of the present century! if any of us shall be spared to witness

*A Lecture delivered at the City of London College in 1861.

them. How many, and how strange and wonderful, have been the events and the discoveries since the year 1800! Firstly, let us look at the social position of our country at the two periods.

In 1801 England was at war, now she is at peace; then a rebellion in Ireland had just been quelled, now Ireland is enjoying the fruits of peace and prosperity; and although, through emigration, her population has very little increased, yet the land under cultivation has risen to 15,000,000 acres, and the value of her live stock has been trebled; while pauperism and crime, on a large scale, are almost things of the past. Then great political discord and a famine were raging throughout the country, now all is peace at home; food is at a reasonable price, and there is fair employment for the people, who are contented, happy, and united.

The old tinder-box and brimstone matches, such as Guy Fawkes intended to patronise, were then in daily use, for lucifers were not. The rapidity with which these useful little articles are now made is really astonishing; and the machinery used is among the most ingenious ever invented. These lucifers are now found in use in all parts of the world.* What, again,

* The invention of our present lucifer match was great because it was so small, and it now turns out that the production of this most useful, but at the same time most dangerous, firework, was due to a happy thought which flashed through the brain of Mr. Isaac Holden, who so terms the idea in his evidence before the Patent Committee. Mr. Holden had to rise at four in the morning to pursue his studies in chemistry, and experienced the gravest inconvenience from his tedious efforts to obtain a light from flint and steel. He was giving

should we do without pins and needles? go back to the days of clumsy skewers, or to the primitive fish-bones of the South Sea islanders. The year 1800 was before the era of railways, when half the Midland Counties people had no notion what the sea was, but by name, and when our country cousins were content to tarry at home, innocent of excursion trips. It was before the penny post was established, and had increased our correspondence to nearly 600,000,000 letters a year—a quadruple advance even in a quarter of a century; it was before we had india-rubber macintoshes or gutta percha soles; before steam had been harnessed to the plough; before clod-crushers broke down the stubborn soil, or reaping machines cut and gathered the golden corn; it was before ships were "screws," whatever the captains and owners might have been; before the electric telegraph was invented, or gun-cotton exploded, or men's ugly faces were disagreeably depicted in photographs by daguerreotype or calotype processes.

lectures at this time to a very large academy. He goes on to say—"Of course I knew, as other chemists did, the explosive material that was necessary in order to produce instantaneous light; but it was very difficult to obtain a light on wood by that explosive material, and the idea occurred to me to put under the explosive mixture sulphur. I did that and published it in my next lecture, and showed it. There was a young man in the room whose father was a chemist in London, and he immediately wrote to his father of it, and shortly afterwards lucifer matches were introduced to the world." Messrs. Bryant and May, the celebrated match-makers, employ upwards of 3,000 hands, and turn out 2,600,000 matches per day.

The general aspect of the world has been entirely changed during the present century. Practical Science, aided by intellectual inquiry, has wrought wonders, which it would fill volumes to relate, and which could not even be barely enumerated in an hour's discourse.

There used to be stationary lands, there are none now. The charms of caste no longer spell-bind the spirit of innovation in India. There is no longer any Company's monopoly restricting progress and trade. Land is thrown open there now to purchase and settlement. The natives share with us in the honours and offices of the Crown. They also make free use of the Indian railways and steamers, which are connecting the interior with the coast.

The Great Wall no longer shuts out foreign influence from China. Armstrong guns and Enfield rifles oppose their matchlocks and long-bows, when it has been found necessary to enforce respect to treaty.

The sealed empire of Japan, as well as the interior of China, has been thrown open to our enterprise and commerce. Chinese emigrants people our settlements in the South, in the East and West, and learn from us and we from them. Chinese become professors in our universities; and eastern potentates send their ambassadors to the courts of Europe. The kings of Siam build steamboats, and, like the Japanese, appreciate them, and quickly learn to navigate them. The steamboat is almost universal now in the interior waters of Africa, America, Europe, Asia, and Australia. Steam communication is maintained from Hull to Iceland; and the very whales are tracked in the Arctic seas by steam.

England is within ten days of America, and she can speak to Continental Europe across the Channel; while the telegraph is slowly but steadily working its way from hence to the Far East. Electricity has made a thousand miles as a hair's-breadth.

The Chinese peasant gathers tea for the Lancashire girl, and the Lancashire girl weaves cloth for the Hindoo; while the woollen manufacturers send back to the Tartar the Chinese wool wrought into clothing. Geography has touched the magnetic pole; Archæology has disinterred Egypt and Nineveh; Astronomy has multiplied the planets; Chemistry has remodelled all arts, and surprisingly simplified and cheapened manufactures; while the feats of the Mechanical Sciences can only be told by the hum of the factories, the splash of the steam-ship, the roar of the locomotives; by the resonance of the tunnels, the shafts, the viaducts, that owe their existence to the science and skill of the nineteenth century.*

* Science, in its widest dimensions, has made more rapid progress during the last fifty years than ever before. Has it not, in all its ramifications, taken strides which have rendered former discoveries, however important and however valuable at the time, as the veriest prattlings of childhood? Have not new sciences, as attractive as Astronomy itself, and as replete with lessons of the character of the Great Architect, sprung into being? Not content with tracing the relationships existing amongst material substances and organised beings, have not the sympathies between mind and mind been marvellously exhibited through the phenomena of Animal Magnetism? And who can tell where these investigations will end? But what are all those new discoveries, or inventions, or methodical arrangements of things, in comparison with the huge and prodigious strides which have, in these modern

In 1812 there was but one steamboat plying in the United Kingdom, the "Comet," of three-horse power, established by Mr. Henry Bell as a passenger boat on the Clyde, to run between Glasgow and Greenock. Now Great Britain owns 2,000, exclusive of the numbers belonging to other maritime countries.

In the commencement of the present century there were no railways in operation, and very little internal communication by water. But few canals were completed. Now the case is widely different. In the United Kingdom there are about 125 separate canals and branches; these, with the navigable rivers, furnish an extent of communication of about 5,000 miles, formed at a cost of £35,000,000 sterling.

There were employed in the yearly transit of Great Britain with the world and with her own dependencies, in imports only, in 1860, 38,374 sailing vessels,

times, been made in the application of Science to practical purposes; in the converting of all the elements of nature into so many vehicles for the elevation of man in the economic, social, and moral scale; in the rendering of the dust of the granitoid mass into what is infinitely more precious than the gold of Australia; in the bridging of old ocean, and in making its hoary waves but the transport of a speedier communication between one hemisphere and another; in the bringing together into one happy family all the teeming millions of one vast Continent; nay, in the collecting into one dense assemblage all the civilised nations upon earth, that they might see each other's handicraft, and be stimulated to rival one another in all feats of skill and genius? What are all these but pioneers, fellow labourers, in the propagation of the blessed evangel all over the world, just as the invention of Printing formed a powerful auxiliary of the Reformation in the sixteenth century?

and 2,239 steam vessels. Calculating the value of each ship and cargo at £5,000, we have an aggregate value, for the vessels and their cargoes, of £203,000,000 sterling.

The railways now in operation in the United Kingdom extend over nearly 10,500 miles; their cost in construction and capital sunk, is estimated at nearly £400,000,000. In 1860 they supplied means of convenient and rapid transit to 163,500,000 passengers, and their receipts were about £24,500,000.*

Summarising the macadamised turnpike roads, railways, and canals, there have been not less than 130,000 and odd miles formed, at an aggregate outlay of £450,000,000.

If we add to this about £77,000,000 of capital expended on our mercantile marine, we have a gross total of £527,000,000 of money sunk in promoting the travel and commerce of the country.

Such are the transit facilities of Great Britain in the second half of the nineteenth century. With an external commerce of about £350,000,000, and property insured in Great Britain alone to the value of £1,200,000,000 a year, every such aid to speedy transit and facile communication is of high importance.

Montgolfier was one day boiling water in a coffee-pot, the top of which consisted of paper folded in a

* It appears that there are now (1871) 450,000 miles of railroad open in Europe, 180,000 in America, nearly 7,000 in India, 5,000 in Australasia, and 30,000 miles of submarine cables to different parts; this gives a total of 672,000 miles, which is increasing at the rate of about 100,000 miles per year.

spherical form; he saw it swell, and thus gathered the idea of a light machine, made buoyant by inflation. Soon after he constructed a machine of the kind, and Montgolfier was thus the father of balloons, which have now become so common, and so tractable in the hands of our intrepid aeronauts, as scarcely to excite surprise in their frequent ascents from our public gardens during the season. When the boy, James Watt, was playing, as Arago tells the story, with the steam of the family tea-kettle, now marking how its expansive force raised the lid of the utensil; and now, how, condensed into water, it trickled powerlessly down the sides of the cold china cup which he had inverted over it, who could have imagined that, in these simple processes, there lay wrapped up the principle of by far the mightiest agent of civilisation which man has yet seen—an agent that, in a century after the experiment of the boy, would have succeeded in giving a new character to the arts? or who could have surmised when, at nearly the same period, the Philadelphian printer was raising for the first time his silken kite in the fields, that there was an age coming in which, through a knowledge of laws hitherto unknown, but whose existence he was then determining, man would be enabled to bind on his thoughts to the winged lightning, and to send them, with an instantaneousness that would annihilate time and space, across land and sea?

Elihu Burritt, in his eloquent language, thus speaks on the subject:—

"There was a quiet thinker, some thirty years ago, who ventured to propose, in one of the scientific

journals of the day, 'that a telegraphic communication may be held, at whatever distance, without a moment's loss of time in transmission, and equally applicable by day or night, by means of the electric shock.' Great was the ridicule and contempt cast upon this bold and startling proposition. 'All very pretty in theory,' was the general cry; 'but absurd and utopian when you try to reduce it to practice.' 'Right enough in principle, no doubt,' wrote learned men; 'but utterly impracticable, when brought to the business-test of experiment and application.' The world had its laugh, and the quiet thinker died, with unwavering faith in his great idea; yet how little did even he venture to think that scarcely should the green turf have rooted upon his humble grave, ere those lengthening lines of posts, which now fringe the great iron highways of Europe, should rise, like a cloud of witnesses, to justify his bold presentment of a mighty thought, destined to revolutionise the world, in the best sense of the word, to establish new relations between all peoples, and to render thought and action more and more simultaneous and common among mankind. Nay, in this, as in a thousand other cases, reality has outstripped conjecture. The bold predicator of 1825 did not presume to give unbridled license to his imagination. In laying down his chart by which to pilot 'the electric shock,' as the trained and obedient Mercury of man, the utmost limit assigned, as the probable extent of its controllable career, was the circumference of our own shores. But already such narrow boundary is spurned. Across the foundations of the deep sea the exulting messenger flashes its

timeless course, and England, no longer divided from the Continents, touches with her finger the pulsation of all Europe and America, and yields back her own responsive throb."

The locomotive will now travel in as many hours a distance which, in the early part of the century, required as many days to accomplish.* In 1800 it took weeks to convey intelligence between the two towns of Philadelphia and New Orleans, now it can be accomplished in minutes through the telegraph, which only had its existence in 1843. The extent of telegraphs in the United States and Canada is increasing every day. No one not familiar with the subject can form an adequate idea of the immense benefit which the electric telegraph confers upon the people at large, or of the advantage which it is to commercial and business men generally in a country of great extent, like America in particular. By its

* "I love," says Elihu Burritt, "to see one of these huge creatures, with sinews of brass and muscles of iron, start forth from his smoky stable, and, saluting the long train of cars with a dozen sonorous puffs from his iron nostrils, fall back gently into his harness. There he stands, champing and foaming upon the iron track—his great heart a furnace of glowing coals, his lymphatic blood in his boiling veins, the strength of a thousand horses is nerving his sinews—he pants to be gone. He would drag St. Peter's across the Desert of Sahara if he could be fairly hitched to it. But there is a little sober-eyed, tobacco-chewing man in the saddle, who holds him in with one finger, and can take away his breath in a moment, should he grow restive or vicious. I am always deeply interested in the man, for, begrimed as he may be by machinery, he is the physical mind of that large steam horse."

aid the Government at Washington can almost instantaneously communicate with all parts of the Republic. That vast country, 3,000 miles long and 3,000 broad, can be as easily communicated with by the aid of the telegraph, as a single city. But the telegraph system in the United States is only in its infancy. It must increase with the growth of the country; and already that Republic is covered with a network of wires that embraces a distance of probably 50,000 miles.* In our Indian empire we have now many thousands of miles of electric wires; and the antipodes enjoys its benefits. The velocity of the electric fluid on the wires of the magnetic telegraph, according to Professor Loomis's "Astronomy," appears to be 19,000 miles in one second, or in about one second the globe would be passed around; quick enough, certainly, for ordinary purposes!

Here is a specimen of telegraphic correspondence as carried on on the other side of the Atlantic:—

* In 1840 there was not one established line of telegraph. In the United States, now, there are upwards of 4,000 telegraph offices, or at the rate of one for every 7,500 of the population. Nearly every town and village has its telegraph office. The total land extension exceeds 50,000 miles, and nearly 300 miles of submarine cables were in full operation in 1869. There are already stretched over the surface of the earth more than 300,000 miles of telegraph wire, or sufficient to surround the globe more than twelve times. The total length of telegraph lines is nearly 100,000 miles; so that on an average each line works three wires. Frequently several lines make use of the same telegraph poles; and it is not unusual to see in and between large cities as many as sixteen or twenty wires supported on the same series of poles.

"Quebec, January 30. Dear Tom,—I'm freezing. How are you? Yours, Henry Smith." The reply was, in the twinkling of an eye, "New Orleans. Dear Henry,—I'm melting; send me ice by telegraph. Yours, Thomas Haines." Ten years ago this fact would have been put down as a Munchausen!

At a banquet given on the occasion of the submarine telegraph between England and France, Mr. John Brett stated that it was over a cup of tea, early in 1845, that his brother and he first discussed the project, the successful completion of which they were then celebrating; and in the month of July in the same year, they drew up a plan for not only uniting England and France, but Ireland and our distant colonies in India. Some of the most eminent engineers, he said, regarded the scheme as impracticable; but the jest of yesterday was the fact of to-day. Mr. Brett mentioned the remarkable fact that, in 1666, one Gilbert published a book, in which he said that the day was not far distant when man would be able to communicate from one end of the world to the other by means of electricity. This prediction may now be said to be in course of realisation, if not actually realised; not only Paris and Vienna, but Constantinople, Calcutta, Pekin, and Melbourne will, probably, in a few years be our next door neighbours.*

Previous to the introduction of steam, 11 sailing boats—celebrated hoys—used to convey passengers to and from Margate, making the passage in twenty

* The following statistics of Electric Telegraphs open for the use of the public in the United Kingdom in 1857 are

to thirty-six hours. In 1815 a steamboat commenced running to Margate, reducing the passage to twelve hours, which was considered a marvel; the General Steam Company's boats have since done it in four

interesting now that the whole have passed into the hands of the Government :—

	1.	2.	3.	Total.
Miles of Telegraph	5,637	3,441	301	9,379
„ of Wire...	29,498	15,688	1,296	46,482
No. of Stations open for the public	460	230	80	770
No. of Instruments	2,938	574	141	3,653
No. of Messages sent by the public	844,668	356,186	40,309	1,241,163

1. Electric and International Telegraph Company. On the 1st January, 1858, this company had sixty-eight agreements with railway companies and public offices for their business messages. The number of such messages is not recorded, but is estimated as amounting to three times the number of the messages sent by the general public. This company also furnished intelligence to 142 provincial journals and to fifty-five different reading-rooms, but no record is kept of the number of those messages.

2. The British and Irish Magnetic Telegraph Company. The number of messages to and from the Continent, transmitted jointly by this company and the Submarine Telegraph Company, and the number of messages for railway companies, newspapers and news-rooms are not included with the messages for the public, but are estimated at about 250,000 messages per annum.

3. The South Eastern Railway Company's Telegraph. This company has no working arrangements with either of the

hours. In the same year a steamer ran from London to Gravesend, the average passage being five or six hours, and the fares 4*s.* and 2*s.* There were then 26 sailing passage-boats plying between London and Gravesend, which were soon beaten off by the steamers. In 1821 about 27,000 passengers travelled between London and Gravesend; thanks to rail and steam, the number is now about 2,000,000 annually.*

Nothing, now-a-days, is permitted to run to waste. Science has taught us to collect and employ to profit every description of refuse—bones for pulverising and

electric telegraph companies. To show the progress that has been made under Government management I may state that in 1871, 5,098 telegraph offices were open throughout the country, this number being nearly double those that were open when the business was taken over by the State in February, 1870, and about 13,000,000 messages are sent annually.

* It is less than fifty years since George Stephenson opened the Stockton and Darlington Railway, the first line used for passenger traffic, and already the whole country is covered with a network of iron railways, and 10,000 locomotives convey goods and passengers over thousands of miles of British railway. It is calculated that 200,000 steam engines are employed at present as the motive power of our mills, mines and factories. Look at our ports and rivers! We have men among us who were alive when the shrewd Yankees sneered in 1807 at "Fulton's Folly," as the first steam-boat was called. Now we have steam vessels innumerable, from the tiny tugs and penny boats of our rivers to the large mail packets, or the gigantic Great Eastern; and our gallant merchants visit every port and traverse every ocean of the globe. Look, again, at our farms! In 1841 the first portable engine was exhibited at Liverpool as a great curiosity. We have now about 15,000 thrashing machines in daily use amongst us.

turning into manure; the refuse of our gas works for ammonia; the sewerage of our cities for manure; our old rags for paper and new clothes, and the most beautiful fabrics for our rooms. Indeed, there is a church near Bergen, Norway, capable of holding a thousand persons, made entirely out of old rags. The relievos outside and the statues within, the roof, the ceiling, the Corinthian capitals, are all of papier mâché, rendered waterproof by saturation in vitriol, lime water, whey, and white of egg.

In the early part of the present century we were glad to be content with quills for our correspondence, and a crow-quill and a goose-quill were the only two varieties of pen. Now we have pens of every size, shape, and material, from steel and gold, to glass and gutta percha, giving employment to hundreds of women and young girls in their manufacture. Steel pens have fallen in price from £7 4*s*. the gross, when first made in 1821, to 2*d*. the gross, for which the commonest are now sold. And of this small article alone, at least 1,000,000,000 are annually made in Birmingham; whilst America has also gone largely into the manufacture.

Three centuries ago a needle, or "neeld," cost one shilling; now, one hundred of the best are sent through the post for the same money.*

> "Our hands may not be idle, then, while the earth
> Furnishes material and the universe a market."

Men are no longer the mere recipients of opinions and antiquated theories; they are thinkers, reasoners,

* See an Article on the Manufacture of Needles and Pins in my "Journal of Applied Science," vol. ii, p. 103.

inquirers. As an effect of this, our age is an age of great discoveries in Science and Art. Hardly has the mind time to recover from the wonder and amazement with which some remarkable triumph of science or art has filled it, than something still more wonderful and marvellous is announced.

When Franklin first flew his electrical kite, when Professor Volta first dissected his frogs, who would have ventured to predict the almost miraculous deeds which have since been performed by the controlled agency of the subtle and invisible fluid which, as far as we know, pervades all nature? They who, with any knowledge of the times in which we live, are disposed to regard with an incredulous eye the scientific projects which are constantly being launched forth by enterprising and ingenious men, so long as they are not positively ridiculous, deserve to have had their lot cast in the darkest of the Middle Ages, when they would have had no means of communication with their fellow creatures residing at a distance, but those furnished by a tardy courier or an uncertain carrier pigeon.

The somewhat uncouth name of photo-galvanography has been chosen by the inventor at once to designate and describe a very curious art, of which the first published specimens were not long since given to the world. It is a process for the production, by the aid of light and electricity alone, and without the aid of mechanical means, of a copper-plate, from which impressions are struck off in the ordinary manner. From first to last the hand of man has nothing to do with the production of the

plate, except by setting in action the chemical forces concerned in the work.

Look what Science has done in four great constructive works alone. There are in the Britannia and Conway bridges, and the Newcastle and Berwick viaducts, or bridges, nearly 4,500,000 cubic feet of masonry, the whole costing not less than £1,280,000.

The great engineering achievement of modern times is, beyond question, the construction of a *hollow beam* through which heavily-laden trains with their ponderous locomotive engine may pass—470 feet in length, weighing 2,000 tons—and the lifting of this enormous mass to the height of 100 feet, at which elevation the tubes now securely rest, uniting the island of Anglesea with North Wales. There already existed, within a short distance of the Britannia tubular bridge, a remarkable structure—the suspension bridge erected by Telford. This elegant specimen of engineering skill has a span of 580 feet; is suspended 102 feet above the level of the sea, and has for thirty years resisted the strain of storms, and continued to form the coach road between the island and the mainland, proving in every respect a national monument, worthy of the master-mind by which it was conceived. And what a masterly achievement was brought before the eyes of all the world in the Glass Palace, which was erected with such fairy-like celerity in our own metropolis in 1851, and the equally beautiful permanent building, now the fashionable resort at Sydenham.

In Canada we have one of the largest bridges in the world, which spans the St. Lawrence, connecting the Grand Trunk Railway with the city of Montreal. Its

proportions are truly Titanic, and the piers upon which it rests are of sufficient strength and solidity to defy the force of the ice which floats down the St. Lawrence in the spring in vast masses. This monster structure is over a mile and three-quarters in length, and rests on twenty-four piers, and two solid abutments. It is on the tubular principle. The principal span, that over the deep or ship channel, is of the extraordinary length of 330 feet, and at an elevation of 60 feet over the summer level of the water, sufficient to allow of the largest lake craft or steamers to pass under without striking even a royal.*

Mechanics has increased the facilities for production and the means of accomplishing an amount of labour, which far transcends the ability of united manual effort to accomplish. The triumphs achieved in this last branch of discovery and invention are prominent enough to mark the nineteenth century as that which has contributed to augment personal comforts, enlarge the enjoyments, and add to the blessings of man. By machinery Great Britain has increased her power equal to a population of 400,000,000 of manual labourers. At the commencement of the

* The Sutlej bridge, which connects Lahore by railway communication with Calcutta and Bombay, crosses one of the most formidable rivers in India. The work occupied about four and a half years in construction. The bridge is 6,468 feet long between abutments, and nearly a mile and a quarter altogether, and is about the second longest bridge in the world. It has fifty-eight girders, each 111½ feet long. The completion of the Mont Cenis Tunnel and the Suez Canal are other great engineering and mechanical works characterising the nineteenth century.

present century, the domestic spinning-wheel began to be superseded by the inventions of Hargreaves, Arkwright, and Crompton, some time having elapsed before the real value of these improvements were appreciated to their full extent. More recently, the finishing hand of Roberts dismissed the spinner, leaving the machine to its own infallible guidance; and now several thousand spindles may be seen in a single room, revolving with inconceivable rapidity, without a hand to urge their progress, or to guide their operations; drawing out, twisting, and winding up as many thousand threads with unfailing precision, indefatigable patience, and strength—a scene as magical to the eye which is not familiarised with it, as the effects have been marvellous in augmenting the wealth and population of our country.

In 1801 the quantity of raw cotton consumed in this country was but 54,000,000 lbs., and the British cotton manufactures were valued at £5,000,000 sterling. In 1860 the consumption of cotton was 1,106,000,000 lbs., and the value of the British cotton goods exported was £52,000,000 sterling, besides our home consumption.

If the whole of the cotton used was spun into what is termed 36's yarn, each pound would produce 30,240 yards of thread, and the whole quantity would amount to 19,002,489,425 miles, or near 200 times the distance between the earth and the sun; and if the same were woven into cloth, 36 inches wide (each piece of 37½ yards, and weighing 7 lbs.), it would form a belt that would encircle the globe 135 times. In the early part of the century the price of the raw cotton was 3*s*. 6*d*. per lb.; it is now 6*d*. or 7*d*.

The total number of cotton factories in Great Britain is 2,500, containing 35,000,000 spindles, and 300,000 power looms. The moving power in these factories is supplied by steam representing 90,000 horse power, and water 9,000 horse power.

It was not till the year 1800 that any considerable quantity of cotton was received from the United States, the imports in that year being 16,000,000 lbs.

Mr. Samuel Maverick, of Pendleton, South Carolina, who assisted in packing the first bag of cotton ever sent from America to Liverpool, is still living; and now the United States exports more than 2,500,000 of bales of cotton every year. The consignee of this lone bag of cotton informed the shippers that he could not sell it, that it was valueless, and advised them to send no more. How little this faithful factor saw into futurity! If any one had said to him that in less than sixty years, and during the lifetime of the boy who had packed that very bale of cotton, millions of bags would be annually sent across the Atlantic for sale in England and France, he would have pronounced him a madman or a fool. But it has been done, and cotton has become the great means by which civilisation is to spread over the earth. This cheapness of cotton fabrics has taught the savage to clothe himself, and exercise industry in obtaining the means of purchasing this companion and evidence of civilisation.

Millions of human beings are employed in the cultivation of cotton, hundreds of thousands in its manufacture, and the whole world are clothed in it. This,

too, has happened in the lifetime of one man still living! *

* When Commerce and Science open up paths of rapid intercommunication throughout the world, the cost of transit of raw material is diminished, and the intellectual superiority of another nation far more than balances the possession of raw material. Roads, railways, ships, and steamboats, arising in the march of science, can spread raw material everywhere, and enable nations to test their relative intellectual powers applied to it. Let us take a case: cotton, being indigenous to Hindostan, calico was made at Calicut. Soon the intellectual culture of the Arabians exceeded that of the Hindoos. Calico was manufactured by them, and introduced into Spain, where it flourished. Then came the great national crime of Spain in the beginning of the seventeenth century, when 1,000,000 of the Moriscoes, who still possessed the experiènce in manufacturing industry, were suddenly expelled on account of their doubtful Christianity. With them, cotton, woollen, and silk manufactures were also ejected from Spain. The 16,000 looms of Seville were thus reduced to 300, and the 40,000 silk weavers of Toledo lost their subsistence as soon as the intelligence and skill of the Moors passed to Tunis. In process of time this country took up the cotton trade which Spain flung away, and we made it our own by great mechanical inventions. Not, be it observed, by manual labour, but by the result of intelligence applied to machinery and locomotion. And look how much intellect now exceeds the value of the raw material as a factor in production. Cotton is grown in America, crosses the broad Atlantic as a bulky and expensive freight, is seized hold of by our mechanical science and manufacturing enterprise, crosses the Atlantic again as calico, pays a heavy import duty, and yet undersells the products of the mills at Lowell. When the great American people, through their rising colleges, and by a better understanding of the effects of restrictive tariffs, apply their intellectual powers in this direction, such relative superiority of manufacturing science will be impossible, in the presence of

There is another branch of industry which I may notice, the machine-made lace and bobbin-net manufacture of Nottingham and Derby—a manufacture which fifty years ago did not exist, but which now produces fabrics of the annual value of upwards of £5,000,000 sterling. Thousands of complicated machines are ever employed in creating those delicate tissues and gauzy screens of fairy-like fabric which veil beauty without eclipsing it, and give their perfect finish to gorgeous robes of satin, silk, and velvet. At the Great Exhibition of 1851 were to be seen on the lace-machine, here plain unpretending net, there elaborately woven lace, ready for the still richer adornments to be lavished on it by the tambour workers. That iron can do, and must do, much of what fingers were wont to achieve, is not to be prevented, and not to be regretted.

In 1801 our imports of foreign and colonial wool were about 7,250,000 lbs.; in 1860 they rose to nearly 148,500,000 lbs.

the raw material at the doors of their mills. More strange still to see Switzerland, with no seaboard, and no coal, bringing cotton from America, transporting it through the defiles of the mountains, then back again over land and sea in the form of high-priced cotton goods, underselling America in her own markets. What enables such a country to do this? It is not cheapness of labour; it is intellectual or scientific superiority in relation to the manufacture, which competes successfully against local advantages. In human progress it is a natural law that the sweat of the brow should be lessened by the conception of the brain. The economy produced by the substitution of cheaper for dearer forms of force is remarkable in all cases where it is applied.—*Dr. Lyon Playfair.*

In 1801 our exports of British woollen goods amounted in value to £5,000,000 sterling; in 1860 the value was more than £16,000,000. The raw and thrown silk imported into this country in 1801 was but 1,000,000 lbs.; in 1859 it was more than 12,500,000 lbs.

As lately as 1820, the value of British manufactured silk goods exported, did not exceed £372,000; in 1860 their value was £2,500,000 sterling.

In 1860 the total value of the British linen manufactures exported was more than £6,250,000, or treble the value of the exports of 1801. These figures will serve to give some idea of the products of industry resulting from scientific improvements.

Who was not struck in the machine room of the late Exhibition with the multiplicity of inventions for accomplishing in the most simple and effective manner, a variety of purposes.* To say nothing of the large

* The prosperity of England depends, not only on the produce of her soil and mines, but also greatly on the number of self-acting machines she keeps at work. In proportion to the increase of the latter has been her increase in wealth and power. Our ancestors had very rude implements to work with, but since the introduction of the steam engine the machinists and engineers of England have gone on applying new machines to every kind of industry, until we have arrived at a time when we have an enormous wealth-producing power at our command. The produce of our mines of coal and iron is so abundant that we can convert the raw material we obtain from other countries into an almost endless variety of things, which add to the comforts of all. The wealth derivable from our mines and self-acting machinery goes on without interruption. The progress that has been made by engineers, during the last forty years has been very remarkable, parti-

sugar mills, centrifugal pumps, coining presses, and so forth, what dexterity and skill were displayed in machines for making needles and pins, aye, and for sticking them on paper; for sewing, for setting up type, for polishing knives in a wholesale style, and for cleaning boots and shoes. Then there were freezing machines for the artificial production of ice, balloting and voting machines for the modest elector; calculating machines; and casks are also now made by machinery. Science even contrives for us guard razors by which the blind may shave themselves; invaluable are they to a nervous man on board a tossing ship. Then we have comfortable gas stoves for our kitchens, and magic spirit stoves with which to cook our chops at a pic-nic on the Pyramids of Egypt, or the summit of Mont Blanc; and pocket kitchens, which contain all the apparatus and utensils to cook for and dine a party of 20 or 30. A walking stick has been made to contain

cularly in constructing and making self-acting machinery. 12*s.* per foot was then paid for the labour of chipping and filing surfaces of iron, which is now frequently done on the planing machine for 1*d.* By Mr. Bessemer's admirable process, the cost of manufacturing some kinds of steel has recently been reduced to one-half, and, in some cases, to one-third what it used to be. The consumption of coal for manufactures has been reduced more than one-half; the saving last year (1869) on the English railways by locomotive engines burning coal instead of coke was £1,200,000 sterling. Mechanical and civil engineers, chemists, and scientific men are continually finding out new modes of producing wealth, and the owners of self-acting machinery generally go on improving and increasing their productions, from which those who have fixed incomes derive great advantage.—*Sir Joseph Whitworth upon Machinery.*

all our toilet apparatus when journeying, and a portmanteau, the furniture and fittings for a couple of rooms, while our pillow or mackintosh coat is converted into a life-buoy or boat at sea. Alarum bedsteads make the sluggard an early riser without his consent, by pitching him out of bed *nolens volens.*

Here is the description of an ingenious invention for early risers,—A mechanic, residing at Hulme, has constructed a little machine for the purpose of awaking himself early in the morning. To a Dutch clock in the kitchen he has attached a lever, from which a wire communicates through the ceiling to the bedroom above, in which he has fixed his novel invention. Having set the lever to any hour at which he may wish to be awakened, when the time arrives it is released by the clock, and the machinery up stairs, rings a bell, then strikes a match, which lights an oil lamp. This lamp runs upon four wheels, and is at the same instant propelled through a tin tube on a miniature railway, about five feet long, which is raised, by small iron supports, a few inches above the bedroom floor. Near the end of the "line" is fixed an elevated iron stand, upon which a small tea kettle is placed, and immediately under it, by the aid of a spring the lamp is stopped, and its flame boils the water in the kettle in twenty minutes, thus enabling him to have a cup of tea or coffee prior to going to work. The machine altogether is of a very neat appearance, the mechanism being of polished iron. It combines utility with economy, as the working of it does not cost more than a halfpenny per week.

If we now turn our attention to the progress of

chemical discovery, what important results do we not see arising from the practical application of that science to the arts and manufactures of our country. Let me select a few instances out of the many that might be cited, in which Chemistry has rendered especial service.

Sulphur is the key of the operative chemist. With it he unlocks Nature's secret drawer, and exposes for public benefit many of its invaluable treasures. Colour making in its various branches, dyeing, paper making, bleaching, the most valuable medical preparations, the instruments of war, the electric telegraph, daguerreotype, and many other arts would scarcely be known but for sulphur. A chemist first makes sulphuric acid, having this, he can prepare nitric acid, hydrochloric acid, and all their compounds; also phosphorus, chlorine, platinum, &c. These lead to a thousand substances used daily in the arts of life.

We may truly judge of the manufactures of a country and its comparative civilisation by the quantity of sulphur that it consumes. In this particular Great Britain stands pre-eminent, our foreign imports amounting to 58,200 tons per annum. A nation will never become commercially and politically great without it can readily procure coal, sulphur, and iron; take either of these away, and its power will sink into insignificance.

At the commencement of the present century, the price of sulphuric acid was 2*s.* 6*d.* per lb., and its sale was comparatively limited. Now, thanks to the improved processes of preparation, and to the researches of Wollaston, who taught us how to form the metallic

grains of platinum into stills, and to dispense with glass retorts, we are enabled to obtain this acid at the low price of 1*d.* per lb. Upwards of 70,000 tons of this acid are now annually manufactured in Great Britain, and there is scarcely a branch of manufacturing industry, which has not either directly or indirectly been benefited by its reduction of price. "Other immediate results of the economical production of sulphuric acid, are the general employment of phosphorus matches, and of stearine candles — that beautiful substitute for tallow and wax. Twenty-five years ago the present prices and extensive applications of sulphuric and muriatic acids, of soda, phosphorus, &c., would have been considered utterly impossible. Who is able to foresee what new and unthought of chemical productions, ministering to the service and comforts of mankind, the next quarter of a century may produce?"—*Liebig.*

Again, as regards soda, formerly we were dependent for our supply of this alkali on Spain and Sicily for barilla, and the Highlands of Scotland for kelp; 6,000 tons per annum of the former were imported, and about 25,000 tons of kelp supplied from the Northern Islands, &c., now the principal portion of the soda employed in various manufactures (such as soap, glass, &c.), and for domestic and other purposes, is obtained from sea salt; and our export alone of this article amounted in 1860 to 102,248 tons, of the declared value of upwards of £1,000,000; whilst our import of barilla has diminished to about 900 tons. The total quantity of soda annually manufactured in Great Britain cannot be short of 300,000 tons; and such is the low price

and good quality of this article, as compared with barilla and kelp, that, comparing the relative prices and qualities, a saving of £5,000,000 sterling per annum is effected on the quantity at present made.

It is the low price of sulphuric acid which has occasioned the cheapness of bleaching powder and soda—the cheapness of soda, which has enabled us to obtain soap, glass, and other industrial products at a lower rate, and thus our leading manufactures have all been benefited to a considerable extent. In 1801 phosphorus was worth more shillings the ounce than it now is per pound. Then we imported all that we required (little though it was) from the Continent. Now we have establishments in our own country for its manufacture in which 20,000 lbs. weight are annually made and sold at 6*s.* per lb. It is estimated that not less than 10,000,000,000,000 of lucifer matches are annually made in this country, besides immense quantities in America and Germany, a trade scarcely dreamt of twenty-five years ago.

That beautiful pigment, ultramarine, which affords the finest blue in the world, is of great importance to our Fine Arts and Commerce, being extensively used by printers, painters, varnishers, and for tapestry. In the early part of the present century it could only be obtained from that rare mineral *lapis lazuli*, and was then worth five to seven guineas the oz.; indeed a very choice and genuine article would often fetch twenty guineas the oz. But chemical investigation was set to work to produce a substitute, and in 1828 a French chemist succeeded in making an artificial ultramarine, which he could sell with profit

at 42*s.* the lb. Its manufacture has been now so simplified that it is sold at from 10*d.* to 1*s.* 3*d.* the lb.

Even the most common and refuse materials are being turned to account. Dr. Penny has recently discovered that the soot from blast-iron furnaces contains about fifty per cent. of potash salt; and, as these salts are of well known value, this discovery will prove of considerable importance to those who are interested in these commercial products, and also to ironmasters, who will be enabled to convert such a substance to practical use.

Prussiate of potash again furnishes an instance of the application of Science to the arts.

Take another palpable instance of the benefits of Science in the progress of candle making. Who cannot remember the rushlights and dips and moulds of tallow, with their feeble flame, guttering propensities, and vile smell. How have these been replaced by the hard composite and stearine candles, the night-lights, the anti-guttering candles, as well as the camphine and moderator and candle lamps, which have all been so cheapened as to be brought into general use!

Science has raised candle making from a clumsy, offensive, mechanical trade into a first-class chemical manufacture, one offering the widest field for applications of the highest chemistry. It is but fifteen years ago that fatty distillation and its attendant processes were put into practice, and now every day some improvement is effected in the processes and in their results. Our imports of the two principal vegetable oils (cocoa-nut and palm oil) have more than doubled. The imports in 1841 were 22,000 tons, and

now they are more than 50,000 tons. Look at the employment these discoveries have given to thousands at home and abroad. One company in the metropolis (Price's Candle Company) employs about 1,300 persons constantly.*

The syrupy body termed glycerine, which serves as a base to the acids of which fat is composed, was formerly looked upon as a nuisance, to be got rid of at a great expense, in the process of candle making. It is now more valued, and sells at a higher rate than its early-prized associate—the stearic acid; for it is a useful medical agent, and can be applied to a number of economic purposes.

Although Wohler obtained aluminium in 1827, it is only of late years that the preparation of this metal has been conducted upon a very large scale. Its remarkable peculiarities are its low specific gravity and its extreme sonorousness. The surface of this metal takes a fine polish, is not acted upon by the air, and is never tarnished. Hence its superiority to silver, and its value in commerce and art, if it could be readily and cheaply obtained. As has been well observed recently, the oxide of aluminium is perhaps of all bodies that which is most universally diffused over the surface of our earth. It is the base of all the clays, which

* The manufacture of paraffine candles has become an important industry, and there are single establishments in Germany capable of turning out 240,000 candles daily. In England and France, the industry has reached vast proportions, and in the United States it has no mean significance. Wagner estimates the production of paraffine candles in Prussia alone, for the year 1870, at 11,000,000 lbs.

contain it in considerable proportions; and the bulk of the various soils is composed of it in varying quantities, together with other earthy (saline and inorganic) substances. What, then, in the course of years may not be expected from this so widely-diffused metal? In centuries yet to come how many things may be made of it, and how manifold may be its uses and applications in the ordinary household and the common arts of life. It appears that we are bountifully provided with a beautiful silvery metal in the very dust under our feet, in the very clay of our roads, and in the soils of our fields. We only wait the advance of metallurgical and chemical science to enable us to obtain a bright metal as cheap as dirt from the very dirt itself.*

But perhaps the best way of realising to our conceptions the actual progress of the last half century would be to fancy ourselves suddenly transported back to the year 1800, with all our habits, expectations, requirements, and standard of living, formed upon the luxuries and appliances collected round us at present. In the first year of this century we should find ourselves eating bread at 1*s.* 10½*d.* the quartern loaf, and those who could not afford this price driven to short commons, to entire abstinence, or to some miserable substitute. We should be grumbling at heavy taxes laid on nearly all the necessaries and luxuries of life—even upon salt—complaining bitterly at the high prices of coffee, tea, and sugar, which confined these articles in any adequate abundance to the rich and easy classes of society; paying twofold for our linen shirts, three-

* "Athenæum."

fold for flannel petticoats, and above fivefold for cotton handkerchiefs and stockings; receiving our newspaper seldom, poverty-stricken, and some days after date; receiving Edinburgh letters in London a week after they were written, and paying 13½*d.* for them when delivered; exchanging the instantaneous telegraph for the slow and costly process by chaise and four; travelling with soreness and fatigue by the "old heavy" at the rate of seven miles an hour, instead of by the Great Western at fifty; and relapsing from the blaze of light which gas now pours along our streets into a perilous and uncomfortable "darkness made visible" by a few wretched oil lamps scattered at distant intervals.

"Oh, the pleasant days of old, which so often people praise,
They wanted all the luxuries that grace our modern days;
Bare floors were strewed with rushes, the walls let in the cold;
Oh, how they must have shivered! in those pleasant days of old."

"A young man alive at this period," wrote Sydney Smith, in a letter published in his collected works, "hardly knows to what improvements of human life he has been introduced, and I would bring before his notice the following eighteen changes which have taken place since I first began to breathe in it the breath of life:—Gas was unknown in his boyhood; he was nine hours sailing from Dover to Calais before the invention of steam; nine hours dawdling from Taunton to Bath before the invention of railroads, instead of four hours flying from Taunton to London; bad roads in the country cost him ten or twelve thousand severe contusions every journey; and bad pavements in London

cost him £15 a year for the repair of his carriage springs; he had no policemen to guide and protect him through the streets, and no cabs to whisk him along if he were tired or in a hurry; he had no umbrella in those days, and no macintosh, or waterproof hats; braces were unknown; game could not be bought.

"If I had the gout," he continues, "there was no colchicum; if I was bilious, there was no calomel; if I was attacked by ague, there was no quinine. There were filthy coffee-houses instead of elegant clubs; quarrels about uncommuted tithes were endless; there were no banks to receive the savings of the poor; the poor laws were gradually sapping the vitals of the country; and whatever miseries I suffered, I had no post to whisk my complaints for a single penny to the remotest corners of the empire."

But the last half century has done for us much more than this.

If a murder is committed, or a carpet bag left behind, or a young lady elopes, a message is conveyed from one country to the other in a few minutes. Before the end of the month we know in London what happened in Bombay in the beginning. Our ideas fly about like magic. In these days men may buy for a shilling a book that formerly cost them a pound. The best literature of the world is within the reach of the denizen of the homely cottage. The treasures of the nation are open to him. The labourer and the mechanic may see for nothing the best pictures and the finest collections of curiosities and art manufactures in the country. A single newspaper in these

days contains more intelligence than did a month's file at the beginning of the century. The printing machine strikes off its tens of thousands in an hour, where the old press struck off its fifties; and the celerity with which intelligence is brought to the printing-office from the remotest regions of the earth, is only to be equalled by that with which it is dispersed. There are now about 1,200 newspapers in the United Kingdom, with a gross circulation of 221,500,000 copies annually, of which the London newspapers issue about 119,000,000; and their cheapness places them in the hands of everybody. The consumption of paper in the Kingdom in 1860 was nearly 208,000,000 lbs.

"The productions of the press may first be contemplated in the more permanent form of the 'library,' the settled form of ancient lore, established science, and enshrined genius. It constitutes the entire treasury of the world's standard intellectual wealth. The library is, as it were, the world's great memory, containing all it knows; it is that cell in the world's phrenology which holds its hoarded masses of fixed thought; it is reflection which has ceased to effervesce, and has crystallised into solid cubic form. Modern meditation is still adding, like the slow accretions of a coral island, its immortal accumulations to the stupendous pile. And of all it still knows, the world must forget nothing. Genius and Science are the two producers whose works are ever enlarging the library. Oratory is pouring forth her syllables of wisdom; Poetry is weaving her spells; History is reporting her events; and Romance is fabricating her mimic histories. In the sphere of Science we behold the astronomer with

his telescope; the chemist with his crucible; the geometer with his diagram; the geologist with his pick-axe; each with his note-book in his hand, ready to record his discovery—that discovery forming but a single line, yet that line a precious and immortal volume. Each is glad to send his little specimen, carefully labelled with his own name, into the great alcoves. So goes immortal thought into Thought's immortal repository. And thus the library, from the spoils of the press, is ever living and ever growing."

What a sorry figure would the establishment of the Sossii and Co. exhibit—the crack publishing house of Augustan Rome, with their few hundreds of unwieldy volumes of rolled parchment, painfully transcribed with a reed or iron pen—beside our Cassell, our Murray, or our Longmans, whose mere advertisement catalogues would furnish more pages than all Augustan Rome ever published.

But the glories of the modern press are yet to be unrolled, when the whole continents of Australia and America are overspread with their dense and living civilisation; when the Rocky Mountains shall, like the back margin of a great book, demark but not divide two great outspread pages of united empire—an empire that shall cover with a busy population the hills and vales, the green river sides, and the broad savannahs of that young continent.

Only think, too, of the results which must inevitably flow from the stream of emigration which has commenced to the western seaboard of the American continent. The junction of the Pacific and Atlantic oceans at the isthmus of Central America, which will

speedily be effected, taken in connection with the golden treasures of Australia and California, must soon bring about a complete revolution in the state of the world.

Those whose memory can reach to the early years of the present century, must feel we have lived in an age of wonders. We have seen a substance, which our ancestors proudly used to obliterate a pencil mark, so moulded to our use as to make man almost an amphibious animal; a noxious vapour, from which they would turn with disgust, made the means of brilliant light, which enables the night almost to rival the day. We have seen the surgeon's knife, to them an instrument of necessary torture, divested of its horror by a discovery, which gives a temporary insensibility to pain, which enables the suffering patient to wake from nothing more than a troubled dream, and find *that* over, under which, without this, his fortitude might have faltered, or his constitution sunk.

Two of the large, powerful, and ferocious grizzly bears, in the menagerie of the Zoological Society, were some time ago successfully operated upon for cataract while under the influence of chloroform. And our very poachers are bringing science to bear on their marauding operations, for the "Perth Courier" tells us that they are catching hares there by laying sponges saturated with chloroform beside their food. We have seen again a power which is inexhaustible so long as the elements of fire and water remain, the effects of which our grandmothers may have witnessed with a sigh, when terminating by a sudden crash the serene music of their tea-kettles, but which, by the combined efforts

of modern Science, has become the very hands and feet of the world; the great and almost universal manufacturer for man; the great propeller by which we rival the flight of the bird, and which so unites the human family that degrees of latitude and longitude are little more than milestones on the great highway of the world. And further, we have seen that subtle power which our ancestors recognised only in the minute spark of the electric circle, transformed into the faithful untiring agent of the human mind—bearing its thoughts from one end of a vast continent to another with an accuracy which would be in vain looked for in any other messenger, and with a speed which far outstrips the action of the mind which formed them.

"Quick as thought" will not do now to express the greatest speed, and "quick as lightning" has become a practical, not merely a figurative expression. Had it happened some two or three centuries ago that some superior mind had discovered the expansive powers of steam, or the rapid passage and magnetising effects of electricity, and had at the same time the mechanical genius for contrivance, to render those properties available, as we now see them in daily and hourly use, what would have been the probable result? It is not unlikely that, to the discoverer of such wonders, the discovery might have been anything but profitable. He would not then have been courted by companies, or fêted by shareholders; neither riches nor honour would have rewarded his labour and anxiety; but his discoveries might have been looked on as miracles effected by no heavenly power, and the monument of his fame have been the faggot and the stake.

Even had no such fate awaited him, the benefit of his discoveries would probably have been confined within narrow limits,—to his own neighbourhood, his own country. The genius of the time would have led him to keep the means by which he produced such astounding effects as secret as possible, for the sake of mystery or profit. He would not have sought to simplify or improve his own discoveries and contrivances by the assistance of others, and, as is supposed to have been the case in ancient times with many discoveries of vast importance, the secret of his art would have died with himself. Different indeed is the case now. Let any man, from the noblest in science to the humblest mechanic, discover or contrive anything which will open a new power to the world, or simplify the most trifling operation in a manufactory, he is received with considerate attention. His discovery is tested in every way, and if found to be of scientific or practical benefit, his name becomes known to fame, and his labours are faithfully rewarded.

There is now no compression of Science; no crowding it in colleges, or locking it up in laboratories; the great object in our day is to discover as much as possible; to make all discoveries as practically useful as possible; to spread the knowledge of them as widely as possible, and to make the means of acquiring that knowledge as plain and as simple as possible. Knowledge, which was formerly enclosed in heavy and expensive volumes, now flies abroad in a lighter form, and offers her blessings at a cost so reasonable as to exclude but very few, who desire it, from a participation in them.

The press of England, America, and the Continent teems with productions, which, at the cost of a few shillings, give sound practical information on all branches of science; and that, too, not mystified by the cramped phraseology of Science, but given in language as simple and intelligible as the nature of the subject will allow. There are now 1,200 Mechanics' Institutions in England and Wales, besides many other philosophical institutions. In most places, too, institutions, similar to that which works within these walls, have been established, for the purpose of imparting knowledge in a pleasing and attractive form, to those whose daily pursuits may exercise the powers of the body more than those of the mind. Here then we have the true commentary on the saying of Bacon, that "Knowledge is power." Power—not in those who have it, to impose on those who have it not—to lead them as the blind instruments of a superior intelligence—as the mere machines by which the profit or the glory of its possessor is to be attained; but power to minister to the comforts and conveniences of mankind; to raise and improve the human character, individually and generally; to give men profitable employment and recreation for their leisure hours; to make them feel they have minds as well as bodies; to give them a new sense in the contemplation of all around them; and to lead them, in all they see and all they know, to trace the good and gracious workings of Him to whom all things belong, from whom they came, and to whom they must return. And after all the knowledge we may have acquired by years of patient application and laborious study, how deficient are we! What said the

great Newton on this subject, not long before he passed away from this earth,—whose noblest son he was,—thus leaving to the world a lesson of humility, by which all men may profit, though they may not be able to fathom the depths of those vast discoveries which have made his name immortal. "I do not know," said this truly great man, "what I may appear to the world; but to myself I seem to have been like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble, or a prettier shell than ordinary, whilst the great ocean of Truth lay all undiscovered before me."

One hardly knows which to admire most in this—the modesty of the man, or the beauty of the language.

Were it possible to call up the embodied wisdom of antiquity from the dark profundity of the past, and show them the modern progress on the real road to Science, even in the discoveries of the present century; how great would be their amazement. Show them a lengthened train of twice a hundred loaded carriages or trucks, gliding smoothly on the iron rail with the velocity of an eagles' flight—dragged on like some long, slim, snaky monster by its locomotive head, with eyes of burning fire, snorting forth their heated respirations, and at every evolutionary pulsation discharging the refuse remnants of their motive power.

Show them a vessel, such a one as the Great Eastern, or one of the Holyhead packets, propelled through the ocean with a velocity of fifteen or twenty miles an hour, without the aid of sails or wind. Show them cities and their thousand streets, shops, public edifices and private dwellings, at night lighted with

the brilliancy of noon-day by an invisible fluid that is weighed and measured with the same precision as oil, wax and tallow.*

Show them the miniature of a fine lady—some dashing belle, with all her resplendent finery, crinoline included—produced with the most accurate minuteness, without a painter or a pencil, except the pencils of the solar rays, merely by exposing the subject to the refractive condensation of the rays of light, through the medium of the camera obscura, imprisoning the reflection on a silvered metal plate, on paper, or on glass.

We almost hear them exclaim, as they shrink from the future, "Hold! let us return to the darkness of the past, and be again shut up from the modern world of witchcraft, magic and enchantment." Detain them a few minutes and desire them to peep through Rosse's or Craig's telescopes, while they take a sweep across the firmament. They find the haze of distance dissolved; the barriers to mortal vision vanished; the veil of the universe withdrawn; the splendour and mag-

* In 1792, in England, William Murdock lighted his own dwelling with gas; in 1803, a machine shop, and in 1805, a cotton factory at Salford were similarly lighted. He began to lecture upon the subject, but not until 1810 could a company get a charter for its manufacture. In 1814, Westminster Bridge was lighted, and in 1815, Guildhall. Gas was then 15*s*. the 1,000 feet. There was great opposition even from scientific men, and also great difficulties from want of machinery to make and use the gas. Gun barrels screwed together were used to convey it from place to place. Finally, however, every obstacle was surmounted, and now there is not a city of any size in the civilised world which is not lighted by gas.

nificence of celestial scenery, with all its grandeur, displayed to human understanding at a glance; the siderial fields of space, passing like a panorama of suns and worlds, with their satellites and rings, brilliant orbs and opaque planets, on the majestic march of time.

We imagine a spirit of uneasiness and a desire to quit this lower sphere and ascend to planets that they recognise as their local habitations in the spirit world on the achromatic field. They may be persuaded to stay and look upon the operation of the electric post.

A London correspondent demands from Paris, Berlin or Vienna, the character of the Bourse, the rise or fall of stocks, prices of exchange, &c., and whilst gazing on the operator's motions, he reads the instantaneous response.

Show them yonder hill obstructing the progress of the grading operations of the labourers on a new railroad. The rock-bound base is charged already, and ignited by the merest movement of a tiny wire, connected with alternate layers of zinc and copper plates submerged in acid; a vast explosive sound bursts upon their ears, and the mountain rocks are flying in mid air. Present a similar explosion at Spithead or in the port of Cherbourg, and the heaving surge gives way and the submarine obstructions are riven from their foundations, shooting upwards to the zenith with volcanic force into the aerial space. These are more than enough for them, yet we look forward to more wonderful occurrences.

It was well observed, recently, by "The Times," that "habit has so familiarised us with the marvellous

triumphs of Physical Science that we have ceased to feel or express astonishment at results which, not so many years ago, would have been dismissed from the consideration of rational men as the visions of a fantastic imagination. To run a railway train over the surface of a country at the rate of a mile a minute; to cross the Atlantic in a steamship in eight or nine days; to communicate with any of the principal towns of Europe in less time than is required to put the words upon paper, and other results of the like nature, have become so completely part of our daily life that we have ceased to regard them as extraordinary. That which is really worthy of note is the rate of progression at which discoveries are made. One miracle seems to beget another. It is Wheatstone and his electric telegraph one year—it is the Crystal Palace the next. One day we have the monster steamship, another, Bessemer's discoveries in the method of working iron. This comes of living in a Scientific age. We are as yet but stumbling at the threshold of the cavern in which the secrets of nature have lain hidden for so many years."

If you will but consider what improvements have taken place in the ordinary dwellings, the furniture, clothes and food of even the very lowest orders of society, as compared with their condition a few centuries ago, you will see how much is due to Skill, Science, and Improvement, and find how greatly we are indebted to Commerce for the large addition to our creature comforts. The wonderful inventions, improvements and discoveries of the nineteenth century, form of themselves one of the most important chapters

in the history of the world, and mark in imperishable records the progress and advancement of society and civilisation.

The arts are like plants, proliferous, and like them too, can only be improved by culture. Most of these improvements spring from very humble and ignoble sources. A fowling-piece, it has been well observed, is a child's popgun elaborated; the clay huts of the Hottentot, and the snow houses of the Esquimaux, are the germs of our marble mansions and our glass palaces; a ship is a ripened canoe; and the steam-engine itself may be traced to covers ejected from primeval cauldrons.

The highest elegancies are descendants of very homely progenitors. Our ladies adjust their shawls of cashmere in front of silvered mirrors, supported by Psyches; primitive belles covered their shoulders with skins of newly-slain animals, and admired their unctuous faces in pans of water and polished stones. A Jacquard loom is an Indian's weaving frame matured; and printed volumes and newspapers are deducible from guippos and historical belts of wampum or papyrus. The desire of improvement—of progress—is inherent with us.

What are half the crimes in the world committed for? What brings into action the best virtues? The desire of possessing. Of possessing what? Not mere money, but every species of the beautiful which money can purchase. A man lies hid in a little, dirty, smoky room for twenty years of his life, and sums up as many columns of figures as would reach round half the earth, if they were laid at length; he gets rich; what

does he do with his riches? He buys a large, well-proportioned house; in the arrangement of his furniture he gratifies himself with all the beauty which splendid colours, regular figures, and smooth surfaces can convey; he has the beauties of variety and association in his grounds; the cup out of which he drinks his tea is adorned with beautiful figures; the chair in which he sits is covered with smooth, shining leather; his table-cloth is of the most beautiful damask; mirrors reflect the lights from every quarter of the room; pictures of the best masters feed his eye with all the beauties of imitation. A million of human creatures are employed in this country in ministering to this feeling of the beautiful. It is only a barbarous, ignorant people that can ever be occupied by the necessaries of life alone. If to eat, and to drink, and to be warm, were the only passions of our minds, we should all be what the lowest of us are at this day. The love of the beautiful calls man to fresh exertions, and awakens him to a more noble life; and the glory of it is, that as painters imitate, and poets sing, and statuaries carve, and architects rear up the gorgeous trophies of their skill, and as everything becomes beautiful, and orderly, and magnificent, the activity of the mind rises to still greater and to better objects. Thus do we find "wisdom, strength and beauty" combined in all the works of the Great Artificer of the Universe.

Let us glance now at what Science has done for Navigation in the present century. Science has, from careful observation, deduced laws by which the navigator may escape the ravages of those devastating

hurricanes, which occasionally bring destruction on all within their reach, and has taught him by circle-sailing how to make the passage round the globe in something less than half the time formerly employed. The advantages of Science in nautical affairs have rarely been more strikingly illustrated than in a fact stated in a late report of the American Navy Department, that by means of the wind and current charts, projected by Captain Maury (the late Superintendent of the Naval Observatory at Washington), the passage from the Atlantic to the Pacific ports of that continent has been shortened by about forty days.

Thanks to the recent important investigations, of the Astronomer Royal and others, respecting the deviations of the compass in iron ships, that instrument may still, in great measure, retain its place as the invaluable guide to the mariner in iron ships as it was formerly in wooden ships.

It took several years to bring to maturity the conceptions of the originators of ocean steam navigation. At length the "Sirius" and "Great Western" achieved the passage of the Atlantic just as Dr. Lardner was demonstrating its impossibility, and established transatlantic steam communication. Vessels of all sizes and varieties of structure were laid down by private individuals and public companies, unaided by Government patronage, to try, in the open race of competition, for mastery on the broad Atlantic. It was an ennobling and heart-inspiring sight, the way in which the energy and enterprise of the English people, left to their own vigour and resources, rushed into the field of ocean steam navigation. Numbers

might lose their money, time, and labour, as Raleigh and their forefathers had done before them; but of the ultimate successful result of that enterprise, which has reduced the passage across the Atlantic from an uncertain one of forty days to a certain one of ten or twelve days, no one did or could entertain a doubt.

Less than a quarter of a century ago the foreign and colonial mails were all conveyed by sailing packets. At that period there was only a mail communication with France four times a week, and with America once a month. The mail passage to and from the latter country was reckoned by weeks. With the East Indies there was no mail communication whatever. The foreign and colonial mails—made up in London on a Wednesday—were dispatched from Falmouth (then the principal packet station of the country) on the following Saturday, three days afterwards, *provided* the wind and weather permitted it.

England is now celebrated for the extent and perfection of her mail packet service; in fact it may be said that she carries the sea-borne correspondence of the whole world. And how cheaply she does it! A letter is brought some 16,000 miles for 6*d*., and a newspaper for 1*d*. From east to west, between China and Chili, passing through the four quarters of the globe, and from north to south, between Hamburg and the Cape of Good Hope, her great mail packet lines extend, and from them an immense number of branch lines shoot out, many of which are thousands of miles in length. From the experience of the past it would appear that the Anglo-Saxon race—who are probably destined ultimately to people the principal

portions of the globe—are alone capable of keeping a footing, as it were, on the great ocean pathways.

Formerly the whole of the sea-borne mail service was performed by Government; now it is performed almost solely by private steam packet companies. There are twelve of those companies which have contracts with the Government for the conveyance of mails. The number of steamers employed in conveying sea-borne letters is nearly 100, the horse power of which is about 30,000, and the tonnage 80,000. The value of these steamers is not less than £3,000,000 sterling. The number of miles which these packets traverse in the course of a year is about 2,000,000.

At the present time all foreign and colonial mails are conveyed in steam vessels. The postal communication with France is twelve times a week, and with America four times a week. The mail passage to and from the latter country is reckoned by days, and I look as regularly for my American letters and papers by the Cunard packets to the hour as I do my communications from Ireland or Scotland.

There is now a mail communication with the East Indies twice a month. Falmouth has ceased to be the port of departure, and Southampton and Liverpool are the chief packet stations in the country. Foreign or colonial mails sent from Southampton are at sea in four hours after they are made up at the General Post Office, and those sent from Liverpool are at sea in twelve hours after they have left London. In 1846 there were only eight steam packets plying between Great Britain and North America; now there are thirty-one.

Our modern steam-moved fortresses, the giant coursers of the ocean, have yet attained but to their mid-growth. Steam, and the chemical agents that will possibly supersede it, have many more tasks to perform than have yet been assigned to them; and for the structure of the vessels machinery is yet required to change their construction from a state of comparative handicraftry to the unerring work of self-acting tools; and they have yet to be made unsinkable and incombustible, two things quite within reach of our existing art.

The great Anglo-Saxon family is now pretty equally divided between the two hemispheres. There are now nearly 40,000,000 in North America and its adjacent islands who speak the English language. The most intimate intercourse and extensive commerce between the two branches of this vast family are felt to be of incalculable importance to their best interests and well-being. They are obeying this necessity by increasing the means and motives of social and commercial intercourse from year to year.

Who can deny that we live in an age in which ocean and earth present magnificent attractions? an age of velocity and progress? California and Australia are attracting thousands to their golden sands, and Britain, with her commerce, her ships, and her merchant princes, commands the admiration of the world; her proud and formidable navy traverse the ocean—that highway of nations; guard her remotest colonies, and float like enchanted castles along her sea-girt shores.

Britain's enterprising sons have steered for India,

and explored her burning plains; have peopled Australia and New Zealand; have set up her standard in the Eastern Archipelago, and on the very borders of the Celestial Empire; have wintered within the Polar circle; and, circumnavigating the globe, have planted her missionaries here and there throughout the lovely islands which dot the Pacific. Within the past half century the navigators of Europe have discovered rivers unknown to song; new islands teeming with population, and have borne to barbarous tribes, civilisation, the bible, and the missionary. Truly our age is one of navigation, discovery, invention, and progress.

Turn now from the sea to the heavens above us.

Astronomy in the past half century has added a number of new planets to the solar system, and within the past few years has been advancing with rapid strides. Scarcely a month passes that does not bring to telescopic ken some hitherto undreamed of celestial stranger. The ancient landmarks of heaven have been removed, and the outskirts of the stellar universe, ransacked, as it were, by the monster tube of Lord Rosse, while stars of every magnitude "in number numberless," have been rescued from the obscurity of incalculable distance. Perhaps the most interesting additions, however, to our astral knowledge are those which have taken place within the comparatively familiar boundaries of our own system. Newspapers teem with accounts of comets of every degree of eccentricity, and of every shade of caudal length and brilliancy; while a brief retrospective glance reminds us that the sovereign sun has had one large and nine

small primary planets added to his train since we made his scientific acquaintance at school, besides a perfect host of secondaries. The past few years have introduced three planets to our notice, and conferred a third ring on the incomprehensible Saturn.

I can do no more here than remind you of the discovery since 1800 of no less than nine of the smaller asteroids; of the wonderful series of calculations which enabled two great astronomers simultaneously to affirm the existence and to indicate the precise position of a new and unseen planet, Neptune, placed at an inconceivable distance on the very limits of our system, and of its instantaneous discovery precisely in the predicted spot; of the enormous telescope constructed by Lord Rosse, which has resolved so many nebulæ, ascertained the existence and structure of so many new firmaments, and enabled us to map out the surface of the moon almost as fully as that of the earth on which we dwell.

Who shall assign a limit to the discoveries of future ages? What will the present half century accomplish? We may look for still greater discoveries, for the intellect of man is awake, exploring every mine of knowledge, and searching for useful information in every department of art and industry. Who can prescribe to Science her boundaries, or restrain the active and insatiable curiosity of man within the circle of his present acquirements?

"We may guess," observes Dr. Chalmers, " with plausibility at what we cannot anticipate with confidence. The day may yet be coming when our instruments of observation shall be inconceivably more powerful.

They may ascertain still more decisive points of resemblance between the planets and the earth. They may resolve the same question by the evidence of sense, which is now so abundantly convincing by the evidence of analogy. They may lay open to us the unquestionable vestiges of art, and industry, and intelligence. We may see summer throwing its green mantle over those mighty tracts, and we may see them left naked and odourless after the flush of vegetation has disappeared. In the progress of years or of centuries we may trace the hand of cultivation spreading a new aspect over some portion of a planetary surface. Perhaps some large city, the metropolis of a mighty empire, may expand into a visible spot by the powers of some future telescope. Perhaps the glass of some observer, in a distant age, may enable him to construct the map of another world, and to lay down the surface of it in all its minute and tropical variations. But there is no need of conjecture, and to the men of other times we leave the full assurance of what we can assert with the highest probability: that yon planetary orbs which spangle the firmament are so many worlds; that they teem with life; and that the mighty Being who presides in high authority over this scene of grandeur and astonishment, has there planted the worshippers of His glory."

I might allude to what Science has done in the healing art—to the long series of improvements in medicine by which life is prolonged and pain assuaged; to the discoveries of iodine, cod-liver oil, and various important remedial agents for the infirmities to which flesh is heir to; to the surgical skill now displayed,

the skilful operations which are conducted in our hospitals, and the crowning discovery of chloroform by which pain is banished or suspended at will. Then to the various improvements in surgical instruments—we have even a mechanical leech to use when necessary. By proper diet, proper clothing, and better medical treatment, the chances of life in England have been very nearly doubled within the last 60 years. And what wonderful artificial limbs are now purchasable—legs and arms, and eyes and teeth, and other substitutes for losses! One exhibitor in 1851, a Mr. Palmer, wore an artificial leg of his own construction, with which he walked and jumped and danced so nimbly as to defy the oldest surgeon to detect which was the true and which the false leg. The enamelled surface is rivalled only by the mechanism of nature, and a lady may wear silk hose and slippers without betraying the loss she has sustained. Possibly the wonderful steam arm of the popular song, may become ere long a reality.

Mr. Palmer has received extensive orders for his patent in this country, and the public may soon expect to see no more timber-toe'd veterans stumping about Greenwich or Chelsea. The dentist who fills the mouth of the beauty with a set of pearly teeth, and the artist who dyes the grey head and covers baldness with an artificial profusion of locks, have now added to their amiable deceptions, those of the American artificial leg, which may lead to awkward mistakes, but it cannot fail to be regarded as a great boon to suffering humanity.

Near St. Sevier, there lives an old soldier with a

false leg, a false arm, a glass eye, a complete set of false teeth, a silver nose covered with a substance resembling flesh, and a silver plate replacing part of his skull. He served under the First Napoleon, and these are his trophies.

Religious men are no longer afraid of Scientific discoveries, the general feeling now being, "Let Truth emerge from the mine; let it come from the laboratory of the chemist; let it descend from the observatory of the astronomer, it will fall in with and not darken the truths of the Gospel, for all truths are radii from the infinite circumference, and all shall meet and mingle and cluster in Christ the centre." It would indeed give melancholy force to the saying, "Much wisdom is much grief," if much wisdom were fatal to our faith, and if he who increased his general knowledge must forfeit his religious hopes. But whilst Science is fatal to superstition, and fatal to lying wonders and monkish legends, it is fortification to a scriptural faith.

The Bible coming from God, and conscious of nothing but God's truth, awaits the progress of knowledge with calm security. It watches the antiquary ransacking among classic ruins, and rejoices in every medal he discovers, and every inscription he deciphers; for from that rusty coin, or corroded marble, it expects nothing but confirmations of its own veracity. In the unlocking of an Egyptian hieroglyphic, or the unearthing of some ancient implement, it hails the resurrection of so many witnesses; and with sparkling elation it follows the botanist, as he scales Mount Lebanon; or the zoologist, as he makes acquaintance with the beasts of the Syrian desert; or the traveller, as he stumbles

on a long lost Petra, or Nineveh, or Babylon: for in regions like these every stroke of the hammer, and every crack of the rifle, awaken friendly echoes, and every production and every relic bring home a friendly evidence. And from the march of time it fears no evil, but calmly abides the fulfilment of those prophecies, and the forthcoming of those events, with whose predicted story inspiration has already inscribed its page. It is not light, but darkness, which the Bible deprecates; and if men of piety were also men of Science, and if men of Science would "search the Scriptures," there would be more faith in the earth, and also more philosophy.

Knowledge is essential to true enjoyment. He who knows not, cannot enjoy; hence the difficulty which we find ever attends an effort to persuade those who have not made proof of the fact for themselves, that enjoyment is to be found in scientific pursuits. Let us suppose two travellers passing through the same country; the one is ever complaining of bad roads, execrable cooks, extortionate innkeepers, dreary scenery, want of amusement, and constant weariness. With him, from Dan to Beersheba, all is barren. The other speaks as one who is journeying in fairy-land! Why this difference? The former has not learned to hold converse with Nature; the latter has, and therefore he finds an old acquaintance in a flower here; makes a new friend in a shrub or even a lichen there: rocks speak; trees sing; streams tune their voices; mountains utter welcomes; the whole universe is to him instinct with life; and his heart leaps within him while he essays to join the noble choir of all created

things and beings in re-echoing the praises of their maker—God!

The botanist in his daily walks; the chemist in his laboratory; the astronomer at his night vigils; and the geologist while tracing out the order, arrangements, and characteristics of rocks—all find true pleasure. He who will may find much relief from cares and business pressure by devoting his spare moments to the theoretical and practical study of some Science. The means for pursuing such study are within the reach of all, and are daily becoming more easy of access. Those who have eyes, and use them in reading Nature's book, may always rejoice that pure enjoyment is theirs, while those only who refuse to use their eyes shall be found complaining that life is a burden.

There is a lesson which all men must learn, and which it were well they should learn in time, and that is, to be content to be ignorant of many things. One who sets about acquiring universal knowledge will find he has undertaken a task far beyond mortal powers, which will end only in disappointment and fruitless labour; in his finding himself, perhaps, the slave of all sciences, but the master of none.

The tastes and powers of the human mind are as varied as the powers of the muscles, or the features of the face; and everyone who sets out with a real desire for useful progress in knowledge, will very soon discover to which of the various paths the natural tendency of his mind inclines. In that direction it were best to turn his principal attention, making one particular subject his main pursuit, though he will neces-

sarily and surely acquire much knowledge on other subjects by the way. In all the different Sciences there is a bond of union, sometimes closer, sometimes more remote, but all, more or less like the planets of our system, throwing light on each other. The division of labour is as essential and advantageous in scientific as in manual occupations; and it is to this, and the ready means of communication between different men and distant countries, that much of the rapid progress in Science in recent times may be attributed, and the application of scientific knowledge, which was formerly matter of learning and curiosity, to matters of practical benefit and use. It is not many years ago that the science of Geology was in the former position. Then men amused themselves by observing the position of the different strata which composed the crust of the earth—how they occurred in the same order in different parts of the world—how in the same strata they found the indented marks of shells, or plants, or trees, or animals; and these things led to speculative theories, based on the unexplained facts discovered, but to little practical benefit. When, however, the light of other sciences was brought to bear on these facts—when the analogies of Natural History, Comparative Anatomy, Botany, and Chemistry were called in aid, demonstrative conclusions were drawn as to the antiquity of the globe on which we live—the different races of plants and animals which it was fitted, at different stages, to produce and support—the changes of climate—the relative position of land and water—and the gradual changes which took place to render it the fit abode of man. All these things not only tend to

enlarge our ideas and increase our wonder and gratitude for the vast scheme of Providence, which has been going on for countless centuries under the same fixed laws, but bring the effect of these laws practically home to all of us, by facilitating the acquirement and production of many things which are common and necessary to all mankind.

Grovio remarks in his eulogium on Lebrija: "No Spaniard was accounted noble who held Science in indifference." The dying words of the great Göethe were "open the shutters and let in more light." So it should be the prayer of all true hearts to the "Father of Light"—more light; more light!

"Woe to all who uphold the wrong—
  Who love Darkness rather than Light—
For Science has opened a broad highway
  For Knowledge, and Truth, and Right.
And He sends forth His car to gather
  The people of many lands,
Until the uttermost nations
  Are grasping each other's hands.

And thus, when the people as one are joined,
  And each to his fellow is known,
Invention, and Art, and Skill shall work
  At the bidding of Science alone.
And who can tell of the greatness
  The world may hope for then?
For the faith that moveth mountains
  Hath entered the souls of men."

Science is part and parcel of the philosophy of the universe—the interpretation of nature. Science is necessary to the individual as well as to the community. Numberless have been its benefits, and every

one has been a gainer by its application. Whatever lightens human toil sets free a portion of the intellect to bask in the light of its native element, and relieves some weak part of humanity from the stress of temptation. Its universality is one excellency of Science. No one nation or age may claim it as exclusively theirs. It is the common property of the species, and should be a link of fraternity binding all men in one brotherhood.

Science no longer burrows for the philosopher's stone, but comes out into the glorious sunshine. She pours a few drops of water into a syphon and raises a hundred tons. Steam is a greater reformer than the sword—electricity than the cannon—the printing press than the forum. Sixty years in the present times, when Science, aided and stimulated at every turn by her own past inventions, and moving forward to fresh discoveries with a momentum proportioned to the rapid increase of mankind, has been sufficient to work changes which centuries, cast in the old, sluggish, mediæval mould, were altogether unable to bring about.

> "Across the seas the sailless vessel flies;
> Throughout the land the steedless chariot plies;
> High o'er the wave the Menai wonder strides;
> While man walks dry-shod *here* beneath the tides.
> Words speed like thought along the electric rod;
> Proud Science is abroad, in semblance of a God."

When we see what has already been effected by means of the glorious press, the mighty steam engine, and the wonderful power of electricity, we are, I think, justified in concluding that by the powerful aid of Science the different races of mankind will ulti-

mately be united into one peaceful family, and advanced to the highest and most perfect condition we are destined to attain in this world.

The progress of Scientific Discovery we see, then, has been magnificent, and its application to the arts of life, remarkable. It is, indeed, a privilege that we should have our lot cast in the second half of the nineteenth century, with the prospect of seeing further improvements yet as the tide of time rolls on; that we should have witnessed such an advance in the elements of material well-being as scientific vision never pictured. In wealth, in the arts of life, in the discoveries of Science, and their application to the comfort, the health, and the safety of mankind; in private and public morality, in the diffusion of knowledge, in religious freedom, and in political wisdom—the period of the last sixty years has carried us on faster and farther than any other period in modern times. The Scientific Discoveries of the present century have done more to promote political improvement, and to secure public liberty, than all the revolutions that were ever planned.

These are the sequences of modern progress—the knowledge of investigating Science and its multifarious applications in new discoveries and inventions in the laboratory, the workshop, and the kitchen; but we hope yet to see invention after invention chasing each other like shadows over the plain, all tending to greater improvements, prosperity, brighter hopes and higher civilisation in our much favoured land.

Such are a few, a very few, of the wonders achieved by Science in the present century. I have been able

to take but a rapid sketch, a mere bird's-eye glance, at some of the most prominent subjects for notice, many of which have wrought the most important changes in social economy and the world's history. Each one of these offers a fruitful field for description; and a good-sized volume might be written to illustrate any one of the many topics I have been able merely briefly to advert to; but the simple fact of my having directed your attention to them, and to the beneficial purposes they have subserved, may, perhaps, lead you to pursue the inquiry for yourselves, to become better acquainted with the history and progress of many of those remarkable scientific discoveries of the past half century which in their results have been fraught with such important benefits to yourselves, and such general good to the world at large. Above all, amid the many wonders which the lofty genius, the inventive skill, and the persevering industry of man have achieved, let us never forget that, if man's works are wonderful, how incomprehensible must his Maker's be, and how surpassingly wonderful is the might, the majesty, and omniscience of the Great Architect of the Universe, who directs and orders all, and whom all the elements obey.

THE COTTON MANUFACTURE.

PRODUCTION AND CONSUMPTION OF COTTON.*

Of the numerous products of the soil, there are none at the present day of greater importance to the civilised world at large, than the downy fibre or wool-like covering of the seeds of the tropical genus of plants so universally known under the name of Cotton.

The great injury which a short supply of cotton from America would inflict on the most numerous and most important body of our manufacturers and operatives, on the prosperity of our Commerce, and on the stability of the public revenue, gives to the subject great and universal interest. Indeed, there is nothing except food itself, which is of such material consequence to the well-being of this country as an abundant supply of Cotton, forming, as it does, the basis of so large a portion of our Commerce, and of the employment of our work-people. We know not how soon the calamity thus foreshadowed may overtake this country, and the imperative necessity becomes greater of mitigating its intensity by every present resource, and of guarding against its recurrence by having recourse to the soil and capabilities of many of our various dependencies for growing cotton.

On the supply of raw cotton does it absolutely depend, whether the population of Lancashire shall, or

* Published in the "Merchants' Magazine," August, 1852.

shall not, be reduced to the state of the bulk of the population of Ireland. The cotton plantations of New Orleans feed the inhabitants of Manchester as directly as the potato fields of Mayo or Galway feed or starve the peasants of Connaught. For this supply we are now almost entirely dependent on a single market;—of an annual consumption of 1,600,000 bales above 1,200,000 bales come from America. "We are not," observed 'The Times,' recently, "particularly apprehensive that any political incidents can operate materially in diverting this immense supply from its usual channel. If Georgia and Florida grow 1,000,000 of bales, England will get her due share; but, suppose they should produce no such crop — what is then to supply our deficiencies? Nor is such a supposition extravagant. The cotton crop is only a little less liable than the potato crop to the influences of the atmosphere; frost or sun, floods or drought, storms or blight, may effectually destroy the pod; with the pod, go the hopes of the Georgian planter; with his hopes go the importations of the Lancashire spinner; and with these importations, go the daily work and the daily bread of hundreds of thousands of Englishmen."

In consequence of our being mainly dependent for an adequate supply upon this one source, and the precarious state of that supply, we are now paying, probably, not less than £7,000,000 per annum more than we ought to do, for the raw material—a sum, larger than that which is required for the support of the whole civil establishment of this country.

If cotton were as exclusively the gift of the United States, as cloves and nutmegs of the Spice Islands,

there would be nothing further to be said, nor would the case be mended by any artificial plantations for the forced production of an unnatural and ungracious crop. If there were but one reservoir for this material, that would be all the more reason for keeping our communication with it as open and unrestricted as possible. But the facts are not so. At present, New Orleans exports the best cotton in the world, and, therefore, nearly monopolises the supply; but the source of its excellence lies in the people, not in the climate—in causes within our reach, not in circumstances beyond our power. These gigantic plantations, which now supply the materials for clothing half the civilised world, have been created from nothing, within these last sixty years,

Many years ago the senior editor of one of the leading American papers, was informed by his venerable friend, Samuel Maverick, Esq., of Pendleton, that when a boy, as clerk in the house of his uncle, Mr. William Turpin, of Charleston, he assisted in packing the first bag of cotton ever sent to Liverpool from the United States. Mr. Maverick is still living, and North America now exports some 2,000,000 of bags of cotton every year! That packed by Mr. Maverick was put up in the seed. This was long before Whitney's invention of the cotton gin. The consignee of this lone bag of cotton informed the house of Wadsworth and Turpin that he could not sell it; that it was valueless; and advised them to send no more. How little this faithful factor saw into futurity! If any one had said to him, that in less than seventy years, and during the lifetime of the boy who had

packed that very bale of cotton, millions and millions of bags would be annually sent across the Atlantic, for sale in England and France, he would have pronounced him a madman or a fool. But it has been done, and cotton has become the great means by which civilisation is to spread over the earth. The cheapness of cotton fabrics has taught the savage to clothe himself and exercise industry in obtaining the means of purchasing this companion and evidence of civilisation. Millions of human beings are employed in the cultivation of cotton, hundreds of thousands in its manufacture, and the whole world are clothed in it. This, too, has happened in the lifetime of one man, still living.

We possess, in our own dominions, millions of acres which might have been rendered just as productive, and it is frequently asked, why we delay so desirable a consummation. It is not a question of protection. It is merely one of enterprise, perseverance, and example.

The gloomy accounts which are so frequently received relative to the cotton crop of America, and our almost total dependence on the Slave States, for the supply of this important commodity, have caused the manufacturers of Lancashire, and our legislators and philanthropists, to turn with renewed interest, this year, to the subject of cotton cultivation in India and our colonies; and once more we hear, as on many former occasions, innumerable expressions of regret at the apathy which the people of England have displayed with regard to all the various modes proposed, from time to time, for making us less dependent on North America for the raw material of our staple manufacture.

Little more than half a century ago we imported about as much cotton from our colonies in the West Indies, as we did from the United States.

In 1820, out of 151,572,000 lbs. of cotton wool imported into Great Britain, 89,999,000 were from the United States. In 1849, out of about 740,000,000 lbs. imported, not less than 640,000,000 lbs. (nearly seven-eighths of the whole quantity consumed) must have been from the United States.

Had the increased production of cotton wool, in our own colonies, since 1820, been going on at the same rate as that of sheep's wool, we should now have been importing only about 800,000 bales from America, in addition to 1,200,000 bales from the East and West Indies, Ceylon, Australia, Natal, and other colonies favourable to its production.

In sixty years, this single branch of British manufactures has become of vital national importance. It is interwoven with all that relates to the employment of our population, of our capital, and of our shipping; and all that concerns our national credit, our solvency, and our domestic peace, contentment and security. Its rapid growth is wonderful; its magnitude is stupendous; and its connection with all that is precious and important in the country is so close and inseparable, that the boldest and the most far-seeing minds in the community cannot contemplate any serious vicissitude befalling it, without the utmost alarm and terror.

To show the extent of the trade, we give the quantity of cotton received from America and the value of the cotton manufactures exported from 1844 to 1851. The

latter is exclusive of cotton yarn, to the extent of £6,500,000 sterling annually:—

Date.	Cotton Manufactures Exported from Great Britain.	Cotton Wool Exported from the United States to Great Britain.
	£	lbs.
1844	24,979,577	486,729,222
1845	25,283,513	605,144,786
1846	24,780,631	346,158,667
1847	22,586,562	351,268,799
1848	21,955,402	572,003,127
1849	20,071,046	576,678,960
1850	21,871,930	365,234,430
1851	23,447,103	468,027,450

It will be seen from the foregoing that the trade between the two countries is immense. It amounts to millions upon millions per annum. It is impossible to form anything like a correct estimate of the real number of human beings who are dependent, directly or indirectly, upon this great trade. But the fact that the consumption has kept steady pace with the production, notwithstanding the immense increase of the latter, and despite the fact, too, that the prices have been high for the last year or two, is well calculated to show the immense increase of the business. This may be readily seen when we state that, within about twenty years, the average crop of the United States has increased from 857,000 bales to 2,355,000 bales, or nearly three-fold.

The cotton planters of the United States recently held conventions at Tallahasee, Florida, and at Macon, Georgia, the chief object of which was to secure a

certain concert of action with reference to the production of that staple.

Bales of American cotton taken for consumption in Great Britain in twelve years :—

1840	...	1,251,300	1846	...	1,585,900
1841	...	1,191,300	1847	...	1,157,800
1842	...	1,160,400	1848	...	1,463,600
1843	...	1,367,300	1849	...	1,590,400
1844	...	1,428,600	1850	...	1,106,771
1845	...	1,574,400	1851	...	1,418,265

The following statistics are embodied in the Report of these meetings, showing the average annual production, and average annual consumption of the world, for each period of five years, from 1825 to 1850 :—

PRODUCTION.

Average from	1825 to 1830 ...	1,231,000	bales per annum.
„ „	1830 to 1835 ...	1,450,000	„ „
„ „	1835 to 1840 ...	1,919,000	„ „
„ „	1840 to 1845 ...	2,561,000	„ „
„ „	1845 to 1850 ...	2,791,000	„ „
	Total ...	9,952,000	

CONSUMPTION.

Average from	1825 to 1830 ...	1,187,000	bales per annum.
„ „	1830 to 1835 ...	1,440,000	„ „
„ „	1835 to 1840 ...	1,943,000	„ „
„ „	1840 to 1845 ...	2,514,000	„ „
„ „	1845 to 1850 ...	2,869,000	„ „
	Total ...	9,953,000	

These results, multiplied by five, will show that

the whole production in twenty-five years has been 49,760,000 bales, and that the consumption in the same time has been 49,765,000 bales, an excess over the production of 5,000 bales, or 200 bales per annum. Of course, perfect accuracy in such a matter is not to be expected.

If arguments were wanting to operate as an incentive to the inhabitants of our colonies for increased exertions in the re-introduction of cotton as one of the chief staple articles of cultivation, the reasons set forth below are of so conclusive a character that not even the most sceptical can offer an objection:—1. That our supply of cotton from miscellaneous quarters (including the United States) has for many years been decidedly, though irregularly, decreasing. 2. That the United States is the only country where the growth of cotton is on the increase; and that there, even, the increase does not, on an average, exceed three per cent., or 80,000 bales annually, which is barely sufficient to supply the increasing demand for its own consumption, and for the continent of Europe. 3. That no stimulus of price can materially augment this annual increase, as the planters always grow as much cotton as the negro population can pick. 4. That, consequently, if the cotton manufacture of Great Britain is to increase at all on its present footing, it can only be enabled to do so by applying a great stimulus to the growth of cotton in other countries adapted for the culture.

The increase of the Cotton Trade of this country is one of the most remarkable incidents in our commercial history.

In 1786 we obtained our supplies of cotton from the following sources :—

	lbs.
The British West Indies furnished.........	5,800,000
The French and Spanish Colonies..........	5,500,000
The Dutch Colonies..............................	1,600,000
The Portuguese Colonies, Brazil	2,000,000
Smyrna and Turkey..............................	5,000,000
Total..............	19,900,000

It was not until the year 1800 that any considerable quantity of cotton was received from the United States, the imports in that year being 16,000,000 lbs.; the first shipment of about 200,000 lbs. having been made only nine years previous. North America now furnishes, as we have already shown, about seven-eighths of the whole quantity we import. The crop of cotton of the United States in 1847 was stated by the Commissioner of Patents, in his report to Congress, at 1,041,500,000 lbs. While the production of this staple has increased to such an extent in the United States, in all other countries, with the exception of Brazil and Egypt, it has decreased.

In 1841 our sources of supply were :—

	lbs.
Italy, and the Italian islands	681,649
Turkey	163,354
Egypt...	8,071,218
East India Company's Territories, and Ceylon	97,388,153
Carried forward...	106,304,374

	lbs
Brought forward...	106,304,374
British West Indies	1,533,197
Hayti	269,631
United States of America	358,240,964
Columbian Republics	1,408,560
Brazil	16,671,348
All other countries	3,564,281
Total	487,992,355
Of which we retained, for home consumption	437,093,631

In 1845 the total imports of cotton into Great Britain were upwards of 716,000,000 lbs.; in 1848 the imports were 6,366,251 cwts., and in 1849 they had increased to 6,745,259 cwts.

The cotton crop greatly fluctuates in amount from year to year, but during average favourable seasons the subjoined number of lbs. has been realised:—

	lbs.
Brazil	39,000,000
United States	700,000,000
Egypt	26,000,000
West Indies	13,000,000
Africa (exclusive of Egypt)	48,000,000
India	190,000,000
Rest of Asia	195,000,000
Mexico and South America (except Brazil)	70,000,000
Elsewhere	18,000,000
Total	1,299,000,000

The cotton wool we imported and re-exported in 1847 was as follows :—

		Imports.		Exports.
From America	bales	870,278	......	111,625
„ Bengal	„	110,139	......	11,100
„ Egypt	„	20,670	......	2,150
„ East Indies ...	„	222,797	......	82,800
„ West Indies ...	„	6,451	......	100
Total bales.........		1,231,035	......	207,775

Averaging 422 lbs. per bale.
Equal to .... lbs. 519,496,770 ... 93,167,050

The relative quarters from whence the supply was derived in 1849, were :—

American....................................	bales	1,477,251
Brazilian	„	163,445
Egyptian	„	73,034
West Indian, &c.	„	9,104
East Indian..................................	„	182,079
Total..................		1,904,913

Averaging 422 lbs. per bale.
Equal to .... lbs. 803,823,288

The manufactured articles, from the raw material, amount to £50,000,000 yearly. £28,000,000, one-half of the whole exports of British produce and manufactures, consists of cotton goods; while our domestic consumption of it amounts, probably, to as much more; and, directly and indirectly, this tropical gossamer gives employment to upwards of 3,000,000 of our people—or one-eighth of the whole population.

The appended figures show the capital employed,

the number of persons directly occupied in the manufacture of Cotton, and the bales of cotton required annually to keep them in employ.

	Bales Consumed in 1849.	Hands Employed.	Capital Invested.
Great Britain	1,819,422	480,000	£73,200,000
Other parts of Europe	983,943	233,000	36,600,000
United States	520,000	160,634	24,409,000
Total	3,323,365	873,634	£134,200,000

Of this large consumption of cotton, 2,800,000 bales were furnished by the Southern States of America, and it supports, through the profits of its fabrication, not less than 4,000,000 whites; whilst the fabrics produced furnish comfortable clothing to millions more, who otherwise would suffer from want of it.

The following table gives the exports of cotton from the United States, for a number of years; also the average price per lb.:—

	Export. Total lbs.	Value in dollars.	Average price per lb.
1821	124,893,405	20,157,484	16·2
1822	144,675,985	24,035,058	16·6
1823	173,793,270	20,445,220	11·8
1824	142,369,663	21,947,401	15·4
1825	176,449,057	36,846,649	20·9
1826	204,535,415	25,025,214	12·2
1827	294,310,115	29,359,545	10·0
1828	210,590,463	22,487,229	10·7
1829	264,837,186	26,575,311	10·0
1830	298,499,102	29,674,883	9·9
1831	376,979,784	25,286,492	9·1
1832	322,215,122	31,724,682	9·8
1833	324,698,604	36,191,105	12·1
1834	384,717,907	49,448,402	12·8

	Export. Total lbs.	Value in dollars.	Average price per lb.
1835	387,358,992	64,861,301	16·8
1836	423,631,367	71,284,925	16·8
1837	444,211,537	63,240,102	14·2
1838	595,952,277	61,556,811	10·3
1839	413,624,212	61,338,982	14·8
1840	743,941,061	63,870,107	8·5
1841	530,204,100	54,330,341	10·2
1842	584,717,017	47,593,464	8·1
1843	792,297,106	49,119,086	6·2
1844	663,633,455	54,063,501	8·1
1845	872,905,996	51,739,643	5·9
1846	547,555,055	42,767,341	7·8
1847	537,219,958	53,415,847	10·3
1848	814,274,431	61,998,294	7·6
1849	1,036,602,269	66,396,967	6·4
1850	635,381,601	71,984,717	11·3

Cotton Manufacture in the United States.

Capital invested	dollars	74,501,031
Cotton used	bales	609,117
Coal consumed	tons	121,099
Value of all the raw material	dollars	34,835,056
Hands employed		102,287
Value of entire product	dollars	61,869,184
Yards of sheeting, &c.		763,678,407

The Cotton crops of the United States for the years ending August 31, 1850 and 1851, were as follows :—

		1850.	1851.
New Orleans	bales	781,886	933,369
Alabama	„	350,952	451,758
Florida	„	181,344	181,204
Texas	„	31,263	45,820
Georgia	„	343,635	322,376
Carried forward...		1,689,080	1,934,527

		1850.		1851.
Brought forward	...bales	1,689,080	...	1,934,527
South Carolina	„	384,265	...	387,075
North Carolina	„	11,861	...	12,928
Virginia	„	11,500	...	19,940
Recd. at N. York by Erie Canal		—	...	797
Total...........		2,096,706	...	2,355,257

Crop of		Bales.	Crop of		Bales.
1848-49	...	2,728,596	1835-36	...	1,360,725
1847-48	...	2,347,634	1834-35	...	1,254,328
1846-47	...	1,778,651	1833-34	...	1,205,394
1845-46	...	2,100,537	1832-33	...	1,070,438
1844-45	...	2,394,503	1831-32	...	987,477
1843-44	...	2,030,409	1830-31	...	1,038,848
1842-43	...	2,378,875	1829-30	...	976,845
1841-42	...	1,683,274	1828-29	...	857,754
1840-41	...	1,634,945	1827-28	...	720,593
1839-40	...	2,177,805	1826-27	...	957,281
1838-39	...	1,360,532	1825-26	...	720,027
1837-38	...	1,801,407	1824-25	...	509,247
1836-37	...	1,422,930	1823-24	...	509,156

The following table gives the cotton export from the whole Union to foreign ports in the year ending August, 1851 :—

From—	To Great Britain.	To France.	To North Europe.	Other Fr'n Ports.	Total.
	Bales.	Bales.	Bales.	Bales.	Bales.
New Orleans....	582,373	130,362	47,786	84,120	844,641
Mobile	249,897	45,460	6,084	20,336	321,777
Florida	56,167	7,805	6,575	—	70,547
Texas	—	—	2,261	—	2,261
Georgia	136,143	11,826	2,993	1,685	153,647
South Carolina..	208,970	25,608	13,159	25,281	268,018
North Carolina ..	—	—	—	—	—
Virginia........	—	—	—	—	—
Baltimore	206	—	200	75	481
Philadelphia.....	2,691	—	—	—	2,691
New York......	184,815	80,297	48,713	7,970	321,795
Boston	1,003	—	1,721	128	2,852
Grand Total ..	1,418,265	301,358	129,492	139,595	1,988,710
Total in 1850..	1,106,771	289,627	72,156	121,601	1,580,155
Increase in 1851 .	311,494	11,731	57,336	17,994	398,555

The home consumption for the year 1851 is thus shown :—

Total crop of the United States, as before stated .... bales		2,355,257
Add—		
Stocks on hand 1st September, 1850 :		
In the Southern Ports	91,754	
In the Northern Ports	76,176	
		167,930
Makes a supply of		2,523,187
Deduct therefrom—		
The export to Foreign Ports	1,988,710	
Less, Foreign included	1,077	
		1,987,633
Stocks on hand 1st September, 1851—		
In the Southern Ports	89,044	
In the Northern Ports	39,260	
		128,304
Burnt at New York, Boston, and Baltimore......		3,142
		2,119,079
Taken for home use .... bales		404,108

Quantity consumed by, and in the hands of, manufacturers north of Virginia :—

1850-51	bales	404,108	1837-38	bales	246,033
1849-50	„	487,769	1836-37	„	222,540
1848-49	„	518,039	1835-36	„	236,733
1847-48	„	531,772	1834-35	„	216,888
1846-47	„	427,967	1833-34	„	196,413
1845-46	„	422,597	1832-33	„	194,412
1844-45	„	389,006	1831-32	„	173,800
1843-44	„	346,774	1830-31	„	182,142
1842-43	„	425,129	1829-30	„	126,512
1841-42	„	267,850	1828-29	„	118,853
1840-41	„	297,288	1827-28	„	120,593
1839-40	„	295,193	1826-27	„	149,516
1838-39	„	276,018			

The estimate of the consumption of the South is as follows :—

	Mills.	Spindles.	Quantity Consumed.
North Carolina	30	—	13,000 bales of 400 lbs.
South Carolina	16	36,500	10,000 „ „
Georgia	36	51,400	13,000 „ „
Alabama	10	12,580	4,000 „ of 500 lbs.
Tennessee	30	36,000	8,000 „ „
On the Ohio, &c.	30	100,000	12,000 „ „

Total to September 1, 1851	60,000 bales.
„ „ 1850	107,500 „
„ „ 1849	110,000 „
„ „ 1848	75,000 „

To which should be added the stocks in the interior towns, &c., the quantity burnt in the interior, and that lost on its way to market; these, added to the crop as given above, received at the shipping ports, will show very nearly the amount raised in the United States in the season of 1851—say, in round numbers, 2,450,000 bales.

If by any convulsion the supply of the raw material should be cut off, how wide-spread would be the resulting destitution and ruin to all nations! The Northern States have rapidly increased of late years in their ability to work up the cotton. Thus, in 1841-42, the growth was 1,683,574 bales, and the United States manufacturers took 267,850, or 15 per cent. The average growth of the two years 1850 and 1851 has been 2,500,000 bales, and 502,400 bales, or 20 per cent., has been wrought up in the United States. Thus the national industry of the North is evolving itself with a rapidity that, in a few years, will cause

it to require the whole of the Southern production, to the exclusion of European rivals.

If the consumption of cotton for the next twelve years continues to increase in the same ratio which it has done during the last twelve years—all other things being the same—the cotton required will be :—

By Great Britain	bales	3,200,000
„ Continent of Europe	„	1,656,000
„ United States	„	954,000
Total................		5,810,000

To be supplied from the United States,	bales	5,055,000
From other sources	„	755,000
Total................		5,810,000

A manufacture employing so vast an amount of raw material, must necessarily be of immense importance. In the year 1824 Mr. Huskisson considered the total value of the cotton manufacture to amount to £33,500,000—this has since been considered too high an estimate for that period. Mr. McCulloch, in the year 1833, estimated its value to be £34,000,000 sterling, and the amount of capital employed in the manufacture, to amount to about the same sum; Mr. E. Baines, who arrived at his result by a totally different process, valued it at £31,338,693 in the same year, and considered Mr. McCulloch's estimate of £34,000,000, as the amount of capital invested in the manufacture, to be very moderate.

The following is Mr. Baines' estimate :—

Total value of the manufacture		£31,338,693
Capital employed in the manufacture		£34,000,000
Quantity of goods exported in 1832 :—		
White or plain cottons	259,493,096	
Printed or dyed cottons	201,552,407	
		461,045.503
Number of persons supported by the manufacture		1,500,000
„ of operatives in the spinning and weaving factories in England	200,000	
„ „ Scotland	32,000	
„ „ Ireland	5,000	
		237,000
Wages earned by the factory operatives		£6,044,000
Power moving in factories :—		
Steam ... horse power	33,000	
Water	11,000	
		44,000
Number of spindles		9,333,000
„ power looms		100,000
„ hand-loom weavers		250,000
Wages earned by ditto		£4,375,000

The increase, however, in the manufacturing production since then has been enormous. The following return shows the number of spindles working in cotton mills in 1846 :—

England and Wales	15,554,619
Scotland	1,729,871
Ireland	215,503
Austria and Italy	1,500,000
France	3,500,000
Belgium	420,000
Carried forward	22,919,993

Brought forward...........	22,919,993
Switzerland	650,000
Russia	7,585,000
United States	3,500,000
States of the Zollverein	815,000
Total	35,470,000

According to an official return issued in 1851, the total number of factories of all kinds in the United Kingdom, was 4,330, containing 26,638,716 spindles, and 298,916 power looms. The moving power employed was 108,113 h.p. in steam and 26,104 in water. The total number of children under 13 years of age, employed in factories, who attend school, is 19,400 boys and 15,722 girls. The total number of males employed between 13 and 18, is 67,864, that of females above 13, is 329,577, and that of males above 18, is 157,806. The total number of persons of both sexes employed in factories is 596,082.

The Cotton Trade employs not less than 2,000,000 of the population of the United Kingdom, and an amount of capital far greater than is to be found engaged in any other trade. The consumption of cotton, at the beginning of this century, was 50,000,000 lbs.; it is now about 800,000,000 lbs. Our supplies are drawn from foreign countries in these proportions:—The United States, 78½ per cent.; East Indies, 10½ per cent.; Brazil, 7 per cent.; Egypt, 3½ per cent.; West Indies, ½ per cent. In 1838, the cotton crop of the United States was 1,300,000 bales; in 1848, it was 2,700,000; in 1849, but 2,000,000—a falling off of 25 per cent. The advance of 1*d.* per lb. last year (1851) made a difference of price on the cotton consumed, of nearly

£3,000,000; and an advance of 3*d.* per lb. by reason of the short crop of 1851, will cost between £8,000,000 and £9,000,000 to the manufacturer.

The cotton imported into Liverpool amounts to more than seven-eighths of the consumption of this material in all our manufactories; one-eighth going to the ports of London, Glasgow, Hull, and some few of the minor ports. The whole quantity received in Liverpool, in 1850, was 1,573,202 bales, worth £12,000,000 sterling; imported in 250,000 tons of shipping, and employing for wages, machinery, and interest of capital invested in the cotton factories, at least £47,000,000 sterling a year, and paying not less than £17,000,000 annually in wages. Of the whole of the cotton imported, five-sixths comes from the United States; the remaining one-sixth from Brazil, Egypt, and India.

In sending bales to Liverpool, from New Orleans, they cost each:—

	Dollars.
For bagging, rope and twine, per bale	2·50
For freight, insurance, commissions, and other shipping charges, in New Orleans	2·50
For freight, insurance, duties, tonnage, and dock dues, commissions, and other charges in Liverpool	14·00
For plantation expenses, which include clothing, pork, farming utensils, horses and mules, &c., which must be furnished every year, not less per bale than	6·00
For overseers' wages, and necessary repairs of gin and mill, not less per bale than	2·50
Making the aggregate expenses equal to, per bale..	27·50

A bale of cotton averages about 400 lbs.

In 1848, the whole quantity of cotton imported was 713,020,161 lbs., of which 600,247,488 lbs. were from the United States and 112,722,673 lbs. from all other parts. In 1849, the total import was 755,469,012 lbs., of which 634,504,050 lbs. were from the United States, and 120,964,962 lbs. from all other parts. In 1850, the total amount imported was 663,576,861 lbs., of which 493,153,112 lbs. were from the United States, and 170,423,749 lbs. from other parts. The quantity imported from the British Possessions in the East Indies was, in 1848, 84,101,961 lbs.; in the following year it fell to 70,838,515 lbs.; and in 1850 it rose to 118,172,742 lbs., or nearly one-quarter of the amount imported from the United States. We believe that increase to be attributable almost exclusively to the higher prices which prevailed in 1850. Some small portion of the increase may have been owing to the improved culture with American seed, and the better quality of native sorts, owing to an improved preparation. The quantity of East India cotton imported in 1840, was equal only to about 11 per cent. of that imported from the United States; but in 1850 it was equal to nearly 25 per cent. From Brazil and the Mediterranean, the imports were nearly equal to 1849 and 1850, but those years showed a great increase on 1848. The British West Indies and British Guiana furnished us, in 1848, with 640,437 lbs.; in 1849, with 944,307 lbs.; and in 1850, with only 228,913 lbs. The whole return shows the important fact, that our dependence upon America for this most valuable staple has been considerably diminished in the last two years; but whether this diminution will continue under a lower

range of prices than those of 1850 remains to be seen. The declared value of the cotton manufactures of all kinds, exported in 1848, was £22,681,200; in 1849, £26,770,135; and in 1850, £28,257,461, or about 40 per cent. of our whole exports. The declared value of the cotton manufactures sent to the United States was, in 1848, £1,713,024; in 1849, £2,055,286; and in 1850, £2,504,280. In 1848, the declared value of our entire exports to the United States was £9,561,909; in 1849, £11,971,028; and in 1850, £14,891,961, or nearly one-fifth of the declared value of our exports to all parts of the world. The official value of our imports from the United States amounted, in 1848, to £23,916,844; and in 1849, to £26,554,941. Great Britain and the United States, therefore, now interchange in a year produce worth above £40,000,000 sterling.

The largest consumer of cotton is the United States—England is the great work-shop, indeed, of the world, but the actual consumption in America, exceeds that of Great Britain and Ireland, and our Colonies, including the exports to Gibraltar and India, where, doubtless, large amounts are re-exported to Spain and the islands of the Indian Archipelago. The "New York Shipping and Commercial List," which is the highest authority on this subject, gives 607,000 bales as the American consumption for 1848—of this, 523,000 bales were delivered to the factories in the North, and 75,000 bales the estimated consumption in the South and West. Turning these bags into lbs., at 400 lbs. each, the amount reaches 242,800,000 lbs., besides the large imports of cotton manufactures.

The following figures from official sources, show the annual consumption of cotton in Great Britain, with the decline in the duty.

	lbs.	Duty per lb.
1801	33,630,390	
1811	89,008,874	
1821	113,896,651	3*d*.
1831	257,941,045	3*d*.
1841	442,270,413	3*d*.
1851	644,550,800	free.

The duty on cotton wool was reduced gradually from £1 5*s*. 6*d*. per 100 lbs. levied in 1814, when imported in foreign ships, and 16*s*. 11*d*. in British ships, until it was made free, in 1845.

In 1849, the quantity of cotton wool imported was	654,288,607 lbs.
Equivalent to	583,000,000 yards.
Worth, when manufactured, 1*s*. 9⅝*d*.—Total value	£52,227,500
In 1839, the quantity imported was	387,902,349 lbs.
Equivalent to	342,826,571 yards.
Worth, when manufactured, 1*s*. 9½*d*.—Total value	£31,712,000

Exports—1839	230,053,673	lbs.—	value	£17,462,286
,, 1846	351,290,749	,,	,,	23,475,941
,, 1849	379,819,550	,,	,,	26,321,719

Cotton yarn and piece goods exported and spun, in lbs. weight—

	Exported.	Spun in England and Scotland.
1844	258,870,745	445,577,480
1845	268,352,474	494,766,487
1846	322,840,410	495,033,109
1847	288,233,241	386,578,359
1848	307,823,178	505,226,683
1849	379,819,550	568,921,433

Declared value of the exports of cotton manufactures and cotton yarn, in the nine years ending 1851—

	Cotton Manufactures.	Cotton Yarns.
1843	£16,254,000	£7,193,971
1844	18,816,764	6,988,584
1845	19,156,096	6,963,235
1846	17,717,779	7,882,048
1847	17,382,293	5,957,297
1848	16,770,868	5,927,956
1849	20,188,874	6,701,920
1850	21,871,930	6,380,948
1851	23,447,103	6,631,896

VALUE OF EXPORTS OF TEXTILE GOODS AND YARN IN 1841, 1851, AND 1871.

	1841.	1851.	1871.
Cotton manufactures	£16,232,510	£28,447,103	£57,635,570
„ yarn	7,266,968	6,631,896	15,054,742
Woollen manufactures	5,528,282	8,371,824	27,184,704
„ yarn	552,148	1,484,435	6,101,777
Linen manufactures	3,347,555	4,112,676	7,521,561
„ yarn	972,466	935,939	2,220,103
Silk manufactures	788,894	1,134,931	2,053,938
Thrown, twist and yarn	—	67,803	1,269,876
	£34,680,823	£46,176,607	£119,042,271

There is, therefore, an increase of no less than £74,361,448, in the declared value of our exports of textile manufactures, since 1841, not including jute and other textiles.

In Asia, and many parts of the continent of India, as well as in several of the islands of the Indian Ocean and Eastern Archipelago, cotton has been cultivated from time immemorial. The plant is indigenous to Africa, and its cultivation has long been

carried on with profit in Egypt, and the Barbary States, Sierra Leone, and many of the old settlements on the Western Coast of Africa. Recently, it has become an object of attention in the Republic of Liberia, in Natal, and the Cape Colony.

The island of Bourbon was long famous for the quality of its cotton, and the Chinese have for a considerable period cultivated it. The cotton plant was grown at a very early period in Mexico. It is now extensively grown in Brazil, and in several of the central and southern American Republics. In the United States, so great has been the extension of its cultivation, that cotton now forms the most important export of the Union.

In the various West India islands cotton was formerly a chief article of export, but it has latterly given place to other staples, and the exports have decreased one-half within the last eight or ten years.

Europe has been and always must be dependent upon other quarters of the world for a supply of cotton. Her climate is generally too cold for the production of this plant. Some small quantities have, indeed, been produced in the southern parts of Spain and Italy. The French Government, during the reign of Buonaparte, attempted its culture in France; and, for that purpose, sent for seed to the United States, and other countries, and offered a premium of one franc for every kilogramme (2 lbs.) of cotton, raised and cleaned ready for shipping. The experiment, however, failed.

Cotton is not only a national object with the United States, as the means of paying for most of her

importations of foreign merchandise, and the interest on her public debt to foreign holders, but is a national object to Great Britain in supplying her immense body of operatives with constant occupation who could not find the means of support without American cotton; and also furnishing full employment for the almost incalculable amount of capital invested, in her towns and villages throughout the kingdom, in machinery, manufactories, and buildings, as well as an immense amount of shipping; without which they could not be sustained, and their present value, vast as it is, would be almost annihilated.

It is also becoming a national object with France, and more or less so, with other portions of the continent of Europe. France, Spain, Belgium, Holland, Germany, Russia, and other European countries, are now supposed to consume about 800,000 bales of American cotton; and when we take into view the cheapness with which this precious textile staple furnishes clothing to the poorer, as well as the higher, or richer classes of the population, and how immensely the value of the article is enhanced by the labour they bestow upon it in manufacturing—may we not consider it a national object to all Europe? One of the most important of the raw materials of commerce, then, is Cotton. It is not particularly attractive to the hasty observer, and is passed with indifference by many. But not so by the careful inquirer, the statesman, the manufacturer, and the political economist. Millions of human beings on both sides of the Atlantic are dependent, directly or indirectly, upon the growth and manufacture of cotton,

and an amount of capital truly enormous is invested in this business, in all its various ramifications. The following summary account of the British importations and exportations connected with the cotton manufacture in 1850 is taken from official sources, and will convey an adequate idea of the vast magnitude of this branch of industry.

Imports :—Raw cotton, 5,934,793 cwts.; cotton yarn, 905,966 lbs., cotton manufactures not made up, of the declared value of £97,561; East India piece-goods, 175,010 pieces, of the value of £68,933; other articles to the value of £297,176; cotton manufactures wholly or in part made up, to the value of £44,315.

Exports: — Foreign and colonial manufactures, cotton manufactures not made up, East India piece-goods, 145,895 pieces, of the value of £58,493; other articles to the value of £93,605; of cotton manufactures wholly or in part made up, to the value of £23,667; cotton yarn, 777,957 lbs., to the value of £81,014; British cotton manufactures (exclusive of lace, patent net, sewing thread, and stockings), 1,358,238,837 yards, to the value of £20,528,150; other descriptions to the value of £236,058; cotton yarn, 131,433,168 lbs., valued at £6,880,948.

The quantity of raw cotton consumed in the cotton manufacture of Great Britain in the year 1850 was 584,200,000 lbs. The total number of cotton factories in Britain is 1,932, containing 20,977,017 spindles, and 249,627 power looms. The moving power in these factories is supplied by steam representing 71,005 horse power, and water 11,550 horse power.

The total number of persons employed in these factories amounts to 330,924. If to these we add the persons not employed in factories—such as hand-loom weavers, calico printers and dyers, makers and repairers of machinery, &c., a total of 700,000 would be obtained.

The total value of the cotton goods and yarn exported in 1850 was £28,252,878. The capital employed in the cotton manufacture of Great Britain, is now estimated at not less than £45,000,000.

Great Britain has imported during the three years ending 1850, the following quantities of raw cotton:—

	1848.	1849.	1850.
From the United States	600,247,488	634,504,050	493,150,112
From the East Indies	84,101,961	70,838,515	118,872,742
From the West Indies	640,437	944,307	228,913
From all other parts	28,030,175	49,182,140	51,322,094
Total......	713,020,061	775,469,012	663,576,861

The total import of cotton into Liverpool in 1851, amounted to 1,748,899 bales; being an increase, as compared with 1850, of 176,444 bales; and of 16,680 bales as compared with that of 1849.

The total deliveries, for home consumption, from the ports of the United Kingdom, in 1851, were 1,661,877 bales; being an average weekly delivery of 31,950 bales, against 29,103 bales in 1850, and 30,530 bales in 1849, The total export of manufactured goods in 1851 exceeded, by 175,000,000 yards, that of any year since 1843. The price of the raw material, which averaged from January to June 6½*d.* per lb., for New Orleans, middling quality,

receded, in the latter half of the year, to the average price of $4\frac{7}{8}d$. This decline in price entailed a loss of from £2,000,000 to £3,000,000 sterling on speculators.

OUR COTTON SUPPLIES.*

Of the four great textile materials which form articles of human clothing—Cotton, Flax, Wool, and Silk—not one is indigenous to Europe. The two first are indigenous to America and Africa, and the others belong to Asia. Yielding to many other fabrics in beauty and texture, for health and comfort in the coldest or the hottest regions the Cotton fabric is invaluable. The use of cotton as a material for clothing appears to have been one of the earliest inventions of mankind. It is not our purpose to trace back the history of cotton production and spinning to the earliest records. Strabo, Pliny, Marco Polo, Herodotus, and others have been often quoted as furnishing details respecting what was then known as to the culture and use of the plant whose downy fibrous matter now figures so largely in the commercial statistics of the world. Our business shall be with the cotton trade of the present century; to state in brief terms the steps by which it has grown to its present gigantic proportions. In connection with the raw material we must incidentally notice the statistics of the manufacture, forming, as it does, in the United

* From an Article published in the "Practical Mechanics' Journal and Scientific Record of the International Exhibition of 1862."

Kingdom alone, nearly a third of that commercial enterprise which envelopes the globe.

There is no industry of the present day which has attained such gigantic proportions as the Cotton Trade. Fully three-fifths of the population of the globe, estimated at 1,200,000,000, are directly or indirectly interested in its production and use. After the cereals, it is a product of the soil which employs more land than any other in its growth, and more hands in its preparation, transport by land and by sea, manufacture, and sale. In the process of spinning, dyeing, and finishing, it has afforded incessant scope for improvements in mechanical skill, led to the employment of a great amount of capital in factories and self-acting machinery, and given employment to an immense number of operatives.

In all its applications to the wants of man, it has rendered services which no one can overlook. On whatever side we turn our eyes, we find it employed in our dwellings, which it decorates in various ways; and it forms the clothing of both men and women. It unites pliability with firmness, elegance with strength; it combines readily in various forms with almost all other textile substances; it takes all colours; it can be made into the most gauzy tissues suited to the demands of the most opulent, or into the coarser and cheaper fabrics required by the poorer classes. And besides these qualities, it has attained a wide and extended sale in the principal markets of the world, which has already reached a magnitude unparalleled and yearly increasing. Marvellous as has been the increase of the production of cotton, and the increase

of cotton manufactures in Britain, Europe, and North America, each year adds a new increment to its amount.

In Great Britain the importation of cotton wool in 1800 amounted to only 43,000,000 lbs.; in 1860 it had reached 1,250,000,000 lbs. The total consumption of cotton on the continent of Europe in 1860 was 1,878,000,000 lbs., and in North America 420,000,000 lbs. Mr. T. Bazley, M.P., calculates that not less than 5,000,000,000 lbs. of raw cotton are annually produced and consumed. "If," he says, "4*d.* per lb. be taken as a fair average price, the value will be above £80,000,000; and if 3*d.*, which would be too low an estimate, the amount would exceed £60,000,000 sterling. And if the population of the globe be 1,200,000,000, and that of the United Kingdom who benefit by cotton production is 30,000,000, what an idea does it convey of the wealth, power, and greatness of our country—that this one-fortieth part of mankind should import nearly one-fourth of all the cotton which the whole universe produces!"

The principal sources of supply of cotton to Europe in 1860 were—

North America	lbs.	1,580,790,000
Brazil	"	22,625,000
West Indies, &c.	"	11,880,000
British India	"	201,740,000
Egypt	"	60,175,000
Total	lbs.	1,878,210,000

To Great Britain—

North America	lbs.	1,115,890,608
Brazil	„	17,286,864
Egypt	„	43,954,064
British India................	„	204,141,168
Other countries............	„	9,666,048
Total..................	lbs.	1,390,938,752

The 12,419,000 cwts. of cotton imported into the United Kingdom in 1860 were valued at £31,567,000, and owing to the advance in price consequent on the stoppage of supplies from the Southern States of America, the 11,223,000 cwts. imported in 1861 were valued at £35,940,000. About 2,500,000 cwts. were re-exported.*

* The "Liverpool Albion" says :—"In the subjoined table we give the number of spindles (both spinning and doubling in every year) in existence at various dates, and the total and average weight of cotton consumed at the same dates.

Years.	No. of Spindles.	Cotton Consumed.	Average.
1849	20,977,000	629,900,000 lbs.	30 lbs.
1856	28,010,000	891,400,000 „	31⅞ „
1861	32,387,000	1,005,000,000 „	31⅛ „
1868	34,215,000	996,197,000 „	29⅛ „
1870	37,718,000	1,070,770,000 „	28⅜ „
1870 Working	35,541,000	1,070,770,000 „	30⅛ „

The factory returns gave the number of spindles "at work" for 1870, but not for any previous year. It is manifest that the whole of the spindles were not at work all the year round in either 1849, 1868, or 1870. The highest average is for 1856, when the consumption per spindle was 31⅞ lbs. The figure

In the British Department of the Exhibition, the Cotton Supply Association of Manchester show a case with a large selection of cottons, evidencing the wide extent of field from which supplies may be drawn.

Taking them geographically, we find here exhibited samples from the following localities :—

The Feejee Islands, New Caledonia and Tahiti.

In Australia—Sydney, Wooloomooloo, Queensland (Wide Bay), Northern Australia, and Southern Australia.

Indian Islands, &c.—Java, Peros, Bankos, Andamans, Seychelles, Philippines, Japan and China, Siam, Ceylon, Tenasserim Provinces, Assam, Indore, Pailghaut, Dhollera, Berar, Oomrawattee, Inglehaut, Chingleput (Sea island, American seed and fine cotton), Dharwar (American seed), Kurrachee (Egyptian seed).

From Africa there are specimens from Egypt, Algiers, Shire Valley, Onitska, Soudan, Gambia, Loanda, Gold Coast, Old Calabar and other parts of the West Coast, from Natal and Kaffraria.

From Asia and Europe—Georgia, Ispahan, Bagdad, Khorassan, Mossul, Jaffa, Smyrna, Latakia, Constantinople, Lanarka, Catania (Sicily), Enos, Attica, Argoly, and Karsous.

From South America there are samples from Peru, Payta, Callao, Bahia, Maranham, Maceio, Pernambuco, San Paulo, Cuenca (Ecuador), San Luis, and Bolivar.

adopted by Sir Thomas Bazley, Henry Ashworth, Esq., and Alexander Redgrave, Esq. (factory inspector), is 31¾ lbs. per spindle. The number of spindles at work this year (1872), we estimate at 37,527,000."

Berbice and British Honduras also show their cotton capabilities; and there are samples of cotton from Jamaica, St. Kitts, Tobago, and East Caicos.

From North America—Edisto Island, New Orleans, Mobile, Upland.

Although this collection is extensive, it by no means represents all the cotton-producing localities; and from an Association which has especially devoted itself to the collection of samples and the diffusion of information as to cotton cultivation, which has also large funds at command, a monthly organ of publicity, and has opened up correspondence, through mercantile and official channels, with so many foreign countries, we had looked for a better display, and more general public information than is afforded in this case. There is not an item of statistics appended, or a word of guide as to comparative values and qualities of the cottons, which would have been of use to many visitors. The display might have been much more complete by appending in all cases the pods, showing by scale the length of staple, and adding some of the subsidiary products obtained, such as crude and refined cotton seed oil, oilcake, cotton waste for paper, the hulled seed, and fibre from the bark of the plant.

The cottons of the Southern States of America are chiefly classed into two groups—New Orleans or Upland, which is a short staple, of a mean length of 1 to 1¼ inch, and is grown inland; and that cultivated upon the islets near the shores of South Carolina and Georgia, termed "Sea island," which is of a long staple, averaging 1½ to 2⅛ inches. The quality of cotton is distinguished by the length, strength, and

silky fineness of its fibre, and by its mellow white colour.

The upland cotton of Georgia is also known by the name of "bowed" cotton, owing to an operation formerly practised of loosening the seed from the cotton wool by striking the pods with a stringed bow.

The finest of all fabrics is made from Sea island cotton, such as muslins, sewing cotton, &c., and much of it is used for mixing with silk, worsted, alpaca, &c. From 300 to 400 hanks to the lb. is as high as is regularly spun of this kind of cotton; but 1,050 hanks, or 501 miles, to the lb. was spun by special effort for the Exhibition of 1851 by Sir T. Bazley.

New Orleans cotton is the great staple of the spinning trade, and is used for making calicoes, fustians, velvets, and almost every kind of cloth and article that cotton is used for, being soft, white, of medium staple, and clean. It is also used for mixing with all other cottons. New Orleans is usually spun from 6 to 30 hanks, or 14¼ miles to the lb. for hosiery and other purposes, and from 30 to 80 hanks for general purposes.

Egyptian cotton is used for making articles similar to those for which Sea island is employed; but it is generally used for warp of a coarser kind than the Sea island. The length to which Egyptian cotton is usually spun is from 60 to 100 hanks to the lb. It is occasionally, however, spun both finer and coarser. The length of staple is from 1 to 1⅜ inches, and it has a fine, easily-spun filament.

Nankeen cotton is of a very short fibre, from ⅝ to

1 inch long. It is not at all an article of commerce here, but at Malta and other places it is so, and at Tunis seems to be preferred to the white cotton of that country, Smyrna, &c. It is only spun from 6 to 14 hanks to the lb.

Brazilian cottons are in good repute, and receive the different appellations of Pernambuco, Bahia, Maceio, Maranham, &c. The Pernambuco enjoyed for a long period the reputation of being superior to any other than Sea island or Bourbon. Pernambuco is the principal cotton-growing province. The interior possesses inexhaustible fields where cotton grows wild; and, if proper roads could be formed, its production might be greatly extended. Brazilian is principally a warp cotton, and is used for inferior qualities and coarser makes of ordinary goods. It is frequently used with American; the length of staple ranges from 1 to 1½ inches. The length to which it is spun is usually from 40 to 80 hanks to the lb., or 10 to 38 miles. From some of the Brazilian cottons yarn up to number 250 may be spun.

Some of the cotton pods from Brazil are of a magnificent quality, the fibres hanging pendant from the capsule to the length of 6 or 7 inches. Cotton is shown from ten out of the twenty provinces of this empire—namely, from Rio Janeiro, Pernambuco, Alagoas, Amazonas, Ceara, Para, Parahyba, San Catharina, San Pedro, and Bahia; it is also grown in several of the others. Our supplies from Brazil have been declining of late years, owing to the establishment of cotton factories in Bahia, Rio, and some other provinces, and to the difficulty of transport to the

coast from the interior, as cotton cannot be successfully cultivated near the coast. Some of the cotton shown from Brazil is of a lightish yellow or buff, and others of the nankeen colour.

In the Venezuelan Court samples are shown from fifteen bales of cotton from Maracaibo, imported by Messrs. Stotterfoht, Sons and Co. of Liverpool, and sold to Thomas Bazley, Esq., M.P., of Manchester, on the 11th April, 1862, at 2*s.* 6*d.* per lb. There are thousands of acres in the provinces of Maracaibo, as also in Guiana, Aragua, and other provinces in Venezuela, where cotton of the best quality might be produced in any quantity. Samples of this cotton in various processes of manufacture are also exhibited by T. Bazley, Esq., and raw cotton from many other parts of Venezuela by sundry contributors. From the British West Indian possessions there are cottons shown from Jamaica, Barbados, Dominica, Trinidad, Demerara, the Bahamas; and also from Hayti.

In Martinique the culture of cotton was never very considerable. In 1779, when it was in its greatest favour, it did not extend to 7,000 acres. It has almost gone out of culture now, and only in a very few localities is the cotton plant met with. There are three or four exhibitors, however, of cotton now.

The Antilles have always been considered the original source of the long-stapled cotton. It formed a portion of the tribute imposed upon the Caribs by Columbus. The districts of San François, of Bailly, and other old settled parts of Guadaloupe and its dependencies, of Desidare, the Saintes, and Marie Galante for a long time furnished supplies to the European

markets. The culture attained its greatest elevation in 1808, when the exports had reached 1,400,000 lbs. The wars of the First Empire; the ignorance of the planters, who permitted the best varieties to degenerate, and introduced commoner but more productive kinds, and the increasing demand for sugar, led to a rapid decline. Meanwhile, immigrants from the Bahamas carried the seed from Guadaloupe to South Carolina, and thus established the element of the commercial importance of the United States in this staple, which led to the fall of the colonial prosperity. This was the origin of the famous "Sea island" cotton. For several years past the French government has endeavoured to revive cotton cultivation in this favoured part of the Antilles; and one of its agents (M. Grellet-Balguerie) is endeavouring to reintroduce and establish the kinds most esteemed, the Sea island and Georgia long-stapled cottons. The exports of cotton from Guadaloupe in 1861 were 33,680 lbs. There are a large number of samples shown, and some of the indigenous cottons produce very fine yarn, as is evidenced by the tarlatans and muslins manufactured from it at Tarare.

The culture of cotton long flourished in French Guiana; but the deficiency of labour, the decline of price in cotton, and the more remunerative rates obtained for other products of the soil, led to its abandonment. But, under the impulse of encouragement given by the local government, it is beginning to revive, and the specimens now exhibited prove the capabilities of the colony for furnishing supplies of excellent quality. The yield per acre on high lands is stated to be

350 lbs. of seed cotton, and on the low lands 500 lbs. to 700 lbs. of cotton.

If labour were but available, an inexhaustible supply of cotton of every description might be produced in British Guiana. All kinds of cotton, from the best long staple down to the finest short staple, might be cultivated there, as the kind which does not thrive in one soil or climate could be produced in another. An extent of sea-coast of 280 miles, from the River Corentyne to the mouth of the Orinoco, would produce cotton vieing with the best in the world. At the commencement of the present century the whole cultivated surface of the colony, from end to end, was a large cotton field. In 1803 the exports amounted to 46,000 bales, of about 350 lbs. each. It only requires some care and attention in collecting seed in order to produce a fibre having the colour, evenness, and strength of Sea island samples. Sir Robert Schomburgk doubts the opinion that the finest cotton will not grow at a greater distance than twenty miles from the sea. "I have sent," he says, "samples of the wild cotton from the interior of the colony, which were admired by competent judges for their fine long staple and silky appearance. No care whatever had been bestowed upon the cultivation of these plants, which grew at a distance of 300 miles or 400 miles from the coast." This opinion is borne out by the fine cotton grown in the interior of Queensland and New South Wales.

Cotton is shown from a large number of sources in Africa—from Liberia, Gaboon, Abeokuta, Natal, Sierra Leone, &c. African cotton has only recently come into

use, but it is found to be excellent for hosiery and many other purposes. As it cards and draws very well, it is liked by those who have used it. It is from 1 to 1¼ inches long, and is spun from 6 to 30 hanks per lb. for hosiery purposes, and from 30 to 60 hanks for general purposes.

The Commercial Association of Abeokuta have forwarded samples of cotton called "akase," cleaned and bowed, and in seed; ordinary native cotton; and green, black, and brown seeded cotton, as well as thread and coarse strong spun cotton, and cotton cloths. The Association states that cotton is obtainable in any quantity, and is now grown extensively throughout the Zambesi country. To obtain a largely increased supply, it is only necessary to open roads and bring money to the market. Upwards of 2,000 bales were exported thence in 1861, and this quantity would have been doubled or trebled if the country had been at peace. The present local price is about 5*d*. per lb. Great quantities of cotton cloths are annually made, finding their way to the Brazils and into the far interior.

The local administration of the French colony of Senegal sends some cotton (*Gossypium punctatum*).

No place is more suitable for the culture of cotton than Senegal, since it is found growing wild, is very prolific, and extremely hard and durable. Notwithstanding the obstacles which at present seem to stand in the way of its systematic culture, there is hope that it may be ultimately carried out with satisfactory results. There is an immense extent of territory between the two rivers which might be devoted to its

culture. The men of Cayor, Oualo, Fouata, and Galam grow cotton to supply their own wants, but the facility with which they can procure European cotton goods, and the absence of any important demand hitherto, has kept the production within narrow bounds. Twisted by the hand, and woven in a rude manner into narrow strips, mixed with silk or wool, the indigenous cotton is converted into stuffs which serve in the country for a medium of exchange, and are known at Bakel and St. Louis under the name of "pagnes soie."

The Government encouragement, and the increase of price resulting from the American civil war, have directed commercial attention to this quarter for supplies. But it is in Lower Senegambia and towards Cassamance that the administrative efforts have been chiefly directed. To meet the demands for cultivation and to prepare the fibre, a complete stock of implements, gins, presses, &c., were imported, and the first consignment of cotton transmitted from this quarter has been received. The cotton of Senegal is fine, and shorter than the ordinary cotton of the Confederate States, but useful for replacing the medium kind. The settlements of Gaboon and the Gold Coast also show fair specimens of cotton.

The cotton plant grows readily in Natal. In 1861 about 2,000 lbs. weight were exported, the first fruit of small experiments. The six samples shown in the Natal Court are specimens of this produce. The main difficulty for the present in the way of success seems to be the readiness with which the colonists find more productive applications of their energies, and the

unwillingness with which the Kaffir enters upon any system of work that ties him to the performance of a certain task at a certain time. The Colonial Government is at the present time making an attempt to encourage the Kaffirs to grow cotton. It would be premature to say much as yet of the prospects of this experiment; but cotton in the pod and in the seed is shown, and also samples grown and ginned by the natives.

The splendid specimens of cotton from Algeria cannot fail to command admiration, as they did at the Paris Exhibition in 1855. Especially are the samples of Georgia and Louisiana cottons deserving of notice, and equal to any produced in other countries for their colour, fineness, and strength of filament. Competent authorities admit that the quality cannot be excelled, and it only remains to produce it in quantity, for which labour and capital are requisite.

In the French Colonial Courts a large collection of cottons, the produce of Algeria and other colonial dependencies, is shown in glass jars, and fine and extensive branches of cotton with the bolls or capsules on are arranged on the walls.

In the Italian Court there is a good collection of native-grown cotton in the pod, cleaned and uncleaned, with the seed, nankeen cotton, and *Gossypium Siamense*, grown in Napoli. Malta also shows white and nankeen cotton, and rough manufactures of it.

The East Indian cottons have been very much improved by attentive culture and better cleaning of late years, and have become largely in request to meet the deficiency in supplies of American cotton, although they cannot replace the qualities of superior American.

Within the last twenty years the general export of raw cotton from India has more than doubled. The imports into Great Britain alone have advanced from 85,500,000 lbs. to 204,000,000 lbs. The indigenous cotton of Berar is of an excellent quality, and second to none that is grown in India. Madras and Surat is the commonest of all cottons, being used only for coarse cloths and other articles of great bulk and little value, and for lowering the quality of American, &c. The staple is from $\frac{5}{8}$ to 1 inch long, and it is usually spun from 6 to 14 hanks to the lb. Bengal cotton is more white and silky, and yields yarn to number 50.

There is a very complete collection of cottons in the Indian Gallery, and Dr. J. Forbes Watson has done much to diffuse information as to the culture, character, and extent of supply of Indian cottons.

In the French settlement of Pondicherry, cotton factories have been in operation for some time, where are produced muslins, pullicates, cambrics, and coarse fabrics called "guineas." To M. Desbassyne, of Richmond, Administrator-General from 1826 to 1828, is due the first idea of a spinning and weaving factory. Owing to the efforts of the first manager, M. Charles Voulain and the Government, which granted large subsidies, this industry has prospered here. One factory under the management of M. Saint Pol, has 16,000 spindles, and gives employment to 500 workmen. The production of thread is about 1,200 kilogrammes per day. Another establishment, that of M. Potier, of Houssaye, supplies the looms of a great number of native weavers. The weaving by machinery

is also conducted by M. Desbassyne, who is represented at Pondicherry by M. Godefroy.

From Reunion or Bourbon there are five or six exhibitors of cotton. Although the soil and climate are well suited to the culture, the production has greatly declined since the possession of the island passed into the hands of the French in 1815. One of the principal colonists, M. de Chaleaurieux, of St. Leu, has lately made strong efforts to bring under cultivation with cotton the waste lands in the lower part of the commune, of which he is administrator. The Bourbon cotton makes a great deal of waste, but it is very uniform, pure, fine, silky, and may be spun to very high numbers.

Specimens of cotton are sent from Siam, and it is to be regretted that the Siamese cannot be induced to cultivate it more extensively. Small quantities are produced in the Lao country. The great distance, and the difficulty of transport to Bangkok, added to the scarcity of labour, have no doubt injuriously operated in preventing the development of the trade. But for these difficulties there is no reason why the alluvial districts of Siam should not produce as fine cotton as the United States, West Indies, or Guiana. Coverlets manufactured in the Lao country from native cotton; cotton thread, coloured with native dyes from Tavoy, and the spindle, usually employed for spinning cotton, are shown in this collection, which is transmitted by Sir Robert Schomburgk.

The production of cotton in Cochin China might be rapidly extended on the high lands which border the rivers to five or six miles in the interior, and at a

future day this district may be made to supply the raw material for a large portion of the French factories.

The subject of cotton cultivation appears to be spreading throughout the British colonies, and there can be but little doubt that ere long this article will form a principal staple of export at places where it has never yet been cultivated.

The natives of Ceylon have raised crops sufficient for their own use from time immemorial, and the native cloth is strong and useful. The capabilities of this island for producing cotton of fine quality and in large quantity are unquestionable. The soil and climate are considered to be superior to that of India for the purpose, and it can be grown equal in quality and cheaper in price than that of the United States. There are at least 12,000 square miles of land admirably suited for its cultivation, and if the production were seriously entertained, in a few years 1,000,000 of bales might be shipped from thence.

In the Indian collection a fine sample of Penang cotton is shown. Cotton has never yet been extensively cultivated in the Straits settlements. It has, however, been long introduced, and the staple of one of the varieties now grown is of a very superior quality, and begins to bear in six or eight months after planting. Bushes have been observed for six years or more in constant bearing. The chief obstacles to the culture there are stated to be the price of labour, and the sudden vicissitudes of climate from wet to dry.

The cultivation of cotton in the new Northern Australian colony of Queensland promises to be a great success, and the samples sent to England on

this occasion have attracted great attention, and been even thought worthy of notice in Parliament by Mr. Bazley. At the local exhibition in the colony, preliminary to the transmission of the collection to England, no less than twelve samples of 10 lbs. each of clean Sea island cotton were brought under the inspection of the jurors, three of which obtained silver medals. One sample of upland or New Orleans cotton also gained a silver medal. Samples of cotton from various other localities in the colony, hundreds of miles apart, were also shown, proving that Sea island cotton of fine texture and quality can not only be grown in the neighbourhood of Brisbane, Maryborough, Gladstone, and Rockhampton, on the coast, but upon the elevated table lands of the colony. One sample picked from plants grown in a garden at Camboon upon the Upper Dawson River, rivalled in texture that grown upon the coast. The first local medal was awarded to Mr. W. Cairncross, of Bunba, for a sample of 3 lbs. of cleaned Sea island; the second to Mr. J. Pratter, of Cooper's Plains, who sends 250 lbs.; and the third to Mr. P. W. Thompson, of Norman's Creek. The difference in the quality of the several samples was barely perceptible. Mr. Pratter obtained from one acre (less six rods) about 1,200 lbs. of seed cotton, which yielded something over 300 lbs. of clean marketable value. To illustrate the benefits to be derived from the supply of cotton as well as sheep's wool from Australia, a few dresses have been manufactured from the beautifully-fine lace thread, number 250, spun by Sir T. Bazley from Queensland cotton, and this blended with fine yarn made from the wool of sheep of the same

colony, has furnished a fabric resembling cashmere in softness and beauty. Some of the Queensland cotton has been priced at 3*s*. 6*d*. per lb.

From New South Wales eight samples of cotton are shown—one grown on the Hunter River in 32° south latitude. The Clarence and Richmond districts, in the northern part of the colony, are stated to be well adapted for cotton. One exhibitor, who speaks from experience, having been in Charleston, considers the climate and soil to be of the same character. Samples of New South Wales cotton are the finest in the Exhibition, and worth about 4*s*. per lb.

In New Caledonia we find two varieties of cotton, of which several samples are shown—one obtained from Florida which the Mission of Conception have put largely into cultivation; the other an indigenous species, with a bluish tinge to the cotton wool.

In Tahiti, wild cotton (*G. incuspidatum*) is found growing spontaneously. There are two exhibitors. It has hitherto not received any attention, but plantations are now seriously contemplated. *G. indicum* and *G. vitifolium* have been introduced. This cotton is long, soft, and of a clean white colour. The Government, desiring to encourage this industry, has since 1858 offered a bounty on exportation of 20 per cent. beyond the price at Papeiti. There is a wild species (*G. religiosum*) found growing on the roads and plains on the borders of the sea; of this there are two varieties, one with a nankeen cotton, the other white, of an inferior quality, and with diminutive capsules. The cultivation of cotton in the Feejees might be advantageously carried on; and we have received from

Dr. Berthold Seemann beautiful specimens of cotton grown in those islands, which it is desired to place under British protection.

Some of the specimens sent from Trinidad were from the Bocas Islands, which were formerly covered with plantations, but abandoned during the last thirty-five years. The present specimens are from the wild trees still scattered here and there over the islands.

From the Bahamas samples of the cotton indigenous to, and now growing wild on, those islands and cays, is sent. The American seed came originally from the Bahamas.

In the Peruvian Court are several specimens of fine cotton; among others, samples from the estate of San Xavier de la Nasca, situated about eighteen leagues from a port of shipment. 500 bales of Peruvian cotton came across the isthmus, and were imported by one of the royal mail steamers. This cotton is of a long staple, and about equal in value to Pernambuco. The actual produce at present is 1,200,000 lbs. annually; but the estate is capable of producing 3,000,000 lbs. annually.

It has been demonstrated that cotton of the finest quality can be produced in the eastern province of the Cape Colony, but no effort has been made to test it upon an exportable scale; no catalogue has yet shown the quotation of any bale or bales of South African cotton sold in the home sales. Some of the amateur growers have lost confidence, and urge that the high winds destroy the plants. This is true of some kinds of seed; but the planters have yet to find out the sort best suited to the soil and climate. The cotton shrub,

indigenous to the colony, would, if cultivated, produce a marketable and remunerative article, worth probably 10*d.* per lb.

Cotton grows in Cochin China spontaneously, and France is looking forward to obtain supplies from thence. It is termed in the country "short silk," and is said to be nearly as good quality as New Orleans. Its thread is long, soft, and silky, and its colour a clear white. 2,000,000 lbs. weight have been exported from Lower Cochin in one year, half of which was sold at Saigon. The soil of the entire country is suited to its culture; but the inhabitants do not much attend to its growth, as they consider it too laborious. The largest portion raised is spun and worked up by the natives for local use.

THE COTTON TRADE.*

It is not our purpose to trace the history of cotton spinning back to the heroic ages, nor to cite Herodotus as witness to the quality of the cotton fabrics of India. Those of our readers who explore classic authors, or who are given to historical research, may read how the contemporaries of Strabo practised the art of printing calicoes; and Pliny will describe to them the *Gossypium* plant, from whose "woolly down was made the beautiful robes which the priests of Egypt delighted to wear." Marco Polo will tell in quaint phrases what progress the manufacture of cotton goods had made in his day, in the far off Empire of Cathay; and in the "Precepts of Eben el Awan" may be read all that was known to the Arabs of the culture

* From "The Technologist," vol. ii, p. 358, 1862.

and use of the plant whose products now figure so largely in our commercial statistics.

Our business shall be with the cotton trade of the present generation; to relate in brief terms the steps by which it has grown to its present gigantic proportions—to nearly a third of the commercial enterprise of that great empire whose commerce envelopes the globe.

Among the many wonderful developments of industrial enterprise, the growth of the cotton manufacture in Britain is, beyond comparison, the most remarkable. In the first year of the present century the cotton goods exported from the United Kingdom were valued at £355,000. In 1860 their value was declared to be £52,013,482; and those taken for home consumption were estimated to be worth £40,000,000.

But great as is the contrast between the cotton exports of the first year of the present century, and the value of the cotton fabrics exported and taken for home consumption in 1860, the figures fail to convey anything like an adequate idea of the wonderful strides that have been made in the productive powers of British industry, skill, and enterprise. Valued at the prices obtained prior to 1815, the cotton goods now annually produced in Britain would be worth upwards of £450,000,000 sterling. At the former period the average value of a yard of manufactured cotton was 1*s.* 5¼*d.*, now it is only 3½*d.*; nor is this all, the article produced at the latter price is greatly superior in texture, appearance, and in durability to the more costly fabrics manufactured prior to the inventions of

Hargreaves, Crompton, Arkwright, and others, to whose ingenuity England is indebted for one of the most important of her commercial interests, and the world for putting within reach of the poorest labourer luxuries that a century earlier could hardly be obtained by the wealthiest noble.

If such figures inadequately represent the annual productive value of the factories of Great Britain, at what capital sum shall we rate the brain labour of those men who have perfected the machinery wherewith such results have been achieved? If England's commercial supremacy is the chief element of her greatness and glory; if Commerce is the best missionary of Civilisation, certain it is that the inventors of those wonderfully productive agents are entitled to a conspicuous niche amongst the benefactors of the human race, and contributors to their country's greatness.

Having in mind the essential maxim of that excellent matron, Mrs. Glass, we shall grow our cotton before we spin it. To this end—as an acre of land, with the best management, will only yield 100 lbs. of the cleaned wool, we must have annually under crop, to meet the current consumption of Europe and America, not less than 19,000,000 acres; and, to ensure a proper rotation, not less that 57,000,000 acres of land are required for the production of the 1,871,000,000 lbs. of cotton wool that feed the spindles of the European and American manufactories. It is probable that an equal quantity is necessary for the Asiatic and African looms; therefore it is fortunate that the *Gossypium* is indigenous to so large a

portion of the earth's service, and that it has been found capable of naturalisation in latitudes extending thirty-five degrees on each side of the equator. It has been cultivated in Italy, in Sicily, and in the south of France. Egypt and Brazil supply large quantities of a superior quality, and recently it has been cultivated in Australia and at the Cape.

Notwithstanding the wide range over which the cultivation of this plant may be extended, embracing the most important colonies of Britain, it is a singular fact that the attention of British capitalists has not, until recently, been directed to the promotion of its cultivation, and the vast interests involved in the manufacture of its products have been almost entirely dependent on the American plantations, so much so that, in 1856, it was boasted by a writer in a New Orleans periodical, that "of the 4,000,000 bales annually consumed, 3,500,000 were produced in the Southern States of the Union."

When the Russian War seriously interfered with the supply of hemp, India supplied its place with "jute" and "sunn;" when British forests were found insufficient to supply the dockyards with timber, India gave them "teak," and now, when the folly and presumption of man threatens to interfere with the accustomed supply of cotton, India is looked to for the means to fill the threatened gap. Nor will she fail. In that vast region, embraced by the Indus and the Himalaya Mountains, and bounded by the Indian Ocean and the Bay of Bengal, there exists a population closely approximating upon 200,000,000, fully two-thirds of whom are subjects of the British Crown;

these, from a period anterior to historic record, have been clothed in cotton. The total quantity of cotton grown in India, according to Dr. Watson, amounts to upwards of 2,400,000,000 lbs. per annum, and demands for its culture certainly not less than 24,000,000 acres.

Great as is the acreage above indicated—nearly three times that of the American cotton fields—it is but small in comparison with the vast extent of British India. The cotton tract in the valley of the Godavery alone is said to be of greater extent than the whole American cotton field. Guzerat, under the present demand, is expected to send forward, during the current year, no less than 300,000,000 lbs., and this district is not one-hundredth part of India. It has been said, on what may be deemed good authority, that more cotton is annually wasted in India than is grown in America; and there is no doubt but that, by stimulating the production, not only will the culture be extended over a greater area, but the productive power of the land will be materially increased. If to the completion of the works of irrigation already in progress and the construction of railways, is added the stimulus of high prices in Liverpool, it seems reasonable to conclude that the supply of cotton from India will rapidly increase.

A recent writer justly observes that, "up to the present, the supply from India has been entirely influenced and over-awed by that from America. Omitting years like 1855, when New Orleans cotton was selling at 10¼*d.*, and Surats (or East India) at 7½*d.*; and coming down to later days, when American cotton

was selling in Liverpool nearly as low as *4d.*, and Surats at *3d.*, we shall see reason to conclude that the development of the power of India to compete with America is, in one respect, a question of price."

Indian cotton is often delayed for months at the place of its growth by want of transport, during which period it is subject to a deterioration of at least $\frac{1}{4}d.$ per lb. The cost of growing it is estimated at $1\frac{1}{2}d.$ per lb.; it costs another $1\frac{1}{2}d.$ to carry it to Bombay (or other port of export), and the freight to Liverpool adds another *1d.* per lb.; hence it cannot be sold in England at less than *4d.* per lb.

In 1845 the largest crop ever produced (up to that date) in America was brought to market, and the price of the superior grades fell to a point which compelled the holder of Indian cotton to sell at *3d.* per lb. This inflicted an actual loss of *1d.* per lb., and purchasers for the European market withdrew their agents from India. As a consequence, the exports during the following year fell to about one-half their previous quantity. On the other hand, when in 1856 the price of American cotton in Liverpool had risen to *6d.* per lb., and Indian to $4\frac{3}{8}d.$, there was imported in the succeeding year the large quantity of 250,000,000 lbs., and last year (1861) this quantity was increased nearly 50 per cent.

In 1788 the efforts of the East India Company were first directed to the promotion of the growth of cotton, and to the improvement of its quality. In the same year was made the first shipment of Indian cotton to England. In 1814 the exports to England

amounted to 4,000,000 lbs., and they have since increased in the following ratio :—

1831	lbs.	25,805,153
1838	„	40,217,734
1845	„	58,437,426
1851	„	84,923,022
1861	„	369,040,448

Next after India we may refer to the gradually increasing production of cotton in Egypt. Its cultivation was first promoted by Mahmoud Pacha, who no sooner became convinced of the fitness of the soil and climate, than he set about the prosecution of the enterprise with such vigour and sagacity, that within two years he exported nearly 6,000 bales of a superior quality to England. In 1858 this quantity had been advanced to 38,248,112 lbs., and in the same year France obtained 7,434,300 lbs. from the same source. In 1855 the total quantity exported was 55,874,300 lbs., and the home consumption was estimated at from 5,000,000 to 6,000,000 lbs.

England also receives large quantities of cotton wool from Brazil. In 1849 the quantity approximated closely upon 31,000,000 lbs., and though it hardly reached 17,000,000 in 1860-61, this falling off is attributed to competition with American supplies, and to the fact that in Brazil cotton cannot be successfully cultivated near the coast: the difficulty of transporting it from the interior adds so much to its cost as to render it unprofitable. The Brazilian government has offered encouragement for the construction of railways, by guaranteeing interest on the outlay, and lines are in process of construction by British capitalists. Their

completion will remove the main difficulty to the increase of the cotton culture, and the exports will unquestionably be largely increased.

India, Egypt, and Brazil are not the only sources to which the British manufacturer can resort for his raw cotton. At the present moment importations of cotton arrive in Liverpool from five distinct regions of the earth—the United States, India, Egypt, Brazil, and the West Indies. Samples have also been produced from the western parts of Africa, as well as from Australia and Natal, of excellent staple and general good quality. Indeed, samples from Queensland and New South Wales, shown at the International Exhibition of 1862, were valued at *3s. 6d.* to *4s.* per lb. The quantity as yet obtained is small. But let us call to mind the rapidity with which the American supply has reached its present importance: less than seventy years ago the exports of cotton from the United States were *nil*; in 1794 they exported but 5,340 bales of 300 lbs. each, which embraced the entire crop. If such small amounts have expanded to the present enormous production, who shall say that Africa, with its teeming population and genial climate, will not speedily increase its modest contribution of 21 bales in 1859, to an amount which, if not equal to that sent from America, may yet startle us by rapidity of increase. It appears from the narratives of Clapperton and Landers, that cotton is grown very extensively in all parts of Africa. Dr. Livingstone tells us of vast ranges of country suitable for the cultivation of the plant. In one place he says: "The markets are well supplied with provisions

by great numbers of women, every one of whom is seen spinning cotton, with a spindle and distaff exactly like those which were in use amongst the ancient Egyptians. . . . . . The cotton was brought to the market for sale, and I bought a pound for a penny. This was the price demanded, and probably double what they ask from each other. We saw the cotton growing luxuriantly all around the market-place from seeds dropped accidentally. It is seen also about the native huts. . . . . . We met on the road natives passing with bundles of cops or spindles full of cotton thread, and these they were carrying to other parts to be woven into cloth."

In a country so congenial to the production of the staple, with a population naturally docile, though fond of display, there requires but the opportunity and the knowledge that they can at once exchange the raw material, so easily obtained, for the fabric they so highly prize, to induce them to apply themselves to cultivating and collecting it at such points as may be selected by the European traders for making the exchange.

Summing up the supplies obtained from all quarters we find that England in 1859 received 1,226,000,000 lbs. of cotton wool, of which 962,000,000 lbs. were from the United States, and the remaining 264,000,000 lbs. from all other countries. In 1860 this enormous quantity had increased to 1,391,000,000 lbs.; but in 1861 it fell back again to 1,257,000,000 lbs.

Such facts, showing as they do the vast preponderance of the supply obtained from one source over that obtained from all others, have not failed to

produce their effect on the public mind here. We find Mr. J. B. Smith holding the following language in a paper read before the Society of Arts in 1857:—"It is much to be desired that our supplies of the raw material for so great a manufacture should be derived from a variety of sources, that we may, as far as possible, be thus protected from the fluctuations in prices incident to good or bad seasons; but, unfortunately, they are chiefly derived from one source. . . . . But not only are we exposed to the danger of being limited chiefly to one source of supply, but to a still greater hazard—namely, that this supply is the production of slave labour. It may be that the institution of slavery, although condemned by all civilised nations, may yet exist for ages in the United States; or it may happen that occurrences may any day endanger its continuance. The alarm created by recent symptoms of discontent among the slaves in that country, is evidence that their owners themselves are not without apprehensions of danger; and it is impossible for those interested in the cotton manufactures of this country to contemplate with unconcern the insecurity on which this vast manufacture rests. This is not a local question, it has become a great national question, and must be forced upon the attention of statesmen of all parties. To me it appears the importance of the subject can scarcely be over-rated."

With such motives to action—so forcibly expressed by one who had the ear of those most interested five years ago—it is not likely that our manufacturers are so unprepared as the Americans imagine. With the

necessity of dealing promptly with this great question, so prominently brought home to them by the present disturbances in the United States, and the blockade of the cotton ports in the Southern Confederacy; with so wide a field for action before them, we may be sure that the commercial enterprise of Britain will not sleep.

The quarrel which was arrogantly assumed to be the precursor of the downfall of the commercial supremacy of Great Britain, bids fair to be the immediate cause of largely increasing and cheapening the world's supply of the raw material, and of giving a greater impulse to the productive powers of the British looms than anything that has happened since the inventions of Hargreaves, Arkwright, and Watt.

As with many other branches of manufacture, that of Cotton was driven into England by the tyranny of continental rulers. It first took root in Manchester about the beginning of the seventeenth century, where it was encouraged by the municipal authorities granting to the political and religious refugees (who brought the art with them) valuable privileges for a nominal consideration, such as the privilege of cutting timber for their looms in the extensive forests owned by the Warden and Fellows of Manchester College. The industrious immigrant was also encouraged by privileges from the Crown. "The Provident Elizabeth," says l'Abbe de Smet, "did not confine her views to the relief of her religious partisans, but sought to transfer into her kingdom those prosperous trades of the Low Countries which adjoining States had looked upon with invidious eyes."

At this time the operative weaver had usually his residence in the country, where, in his garden plot, he eked out his earnings by the cultivation of his small holding. This was a necessity. The uncertainty of procuring a regular supply of material for his loom rendering his legitimate work exceedingly precarious.

The fly shuttle was invented by Kaye, of Bury, in 1750, and in 1760 James Hargreaves had perfected important improvements in the carding processes. In 1762 the father of the late Sir Robert Peel erected one of his improved machines at Blackburn, which did not materially differ from those now in use. In 1757 the same James Hargreaves invented the spinning jenny, and, after several unsuccessful attempts, succeeded in producing a machine with which he could spin eight threads at once. He speedily improved on his first attempt, and constructed a jenny to run eighty spindles. This may be considered as the leading step in that march of discovery which has improved every branch of the manufacture.

Like other benefactors of the human race, Mr. Hargreaves was not destined to reap much advantage from his discoveries. He was hunted from his native place, and settled in Nottingham, where he shortly after died—if not in great poverty, as has been asserted, certainly in very indifferent circumstances.

About the same time, Mr. Arkwright, of Preston, in Lancashire, gave his attention to the improvement of spinning machinery. He was brought up to the humble occupation of a barber, but seems to have been endowed with a rare combination of inventive talent, and a capacity for business. His want of me-

chanical skill was compensated by ardour and perseverance; and he succeeded, after many struggles with adverse circumstances, in perfecting that rare piece of mechanism called at first the "water frame," and subsequently the "throstle," which performs of itself the whole process of spinning, leaving to the workman only the duty of supplying it with material, and of piecing such threads as are accidentally broken.

In partnership with Mr. Strutt, a man of great mechanical ability, Mr. Arkwright erected a mill at Nottingham for spinning yarn with his machinery. In 1771 he removed to Cromford, where he erected another mill, and where he continued to follow up his first great invention, with many important, though subordinate improvements. He was not, however, to enjoy the fruits of his invention without dispute. Like Hargreaves, he was first persecuted as an innovator; then, when the value of his invention was demonstrated by the work they produced, his patents were contested, and, had it not been for his business tact, his inventions would have been pirated by the very men who had ridiculed them and persecuted him.

It is commonly believed, and often appealed to as a fact by the advocates of Protection to home manufactures, that the factory system of Great Britain was fostered into existence by protective duties. So far as this branch of the system is concerned, nothing can be more erroneous. It fought its way in the face of adverse laws. No sooner had Arkwright and his partner surmounted the mechanical difficulties that

lay in their path, than they discovered that they were doomed to ruin, unless they could command sufficient wealth and influence to obtain the repeal of preposterous legislative enactments. It was not until 1774 that Parliament was pleased to recognise the propriety of permitting genuine cotton fabrics to be made and sold, and then only under vexatious excise restrictions. The sapient lawgivers had previously considered it a necessary stroke of policy to ensure the consumption of home-grown material by requiring that a certain proportion of every fabric should be composed of linen yarn. It required no small degree of energy, and involved very great expenditure of time, to beat down the influence wielded by the defenders of home productions.

About 1792 Samuel Crompton learned to spin with one of Hargreaves' jennys, and, being dissatisfied with the quality of the yarn produced, he set about improving it. His efforts resulted in the mule. With his machine—which, not being a mechanic, he had elaborated under great difficulties—he produced a superior article, which excited the public mind, and he was so beset by the prying curiosity of the country people, that, in order to get rid of the vexation, he exhibited his invention to those who chose to subscribe a guinea each. In this way he raised about £50, with which he constructed a superior and larger machine. He took out no patent, but subsequently received £500 from Parliament.

When Arkwright's patents were cancelled, and the use of the nice preparatory processes became general, the full value of Crompton's inventions became known,

and the use of the mule jenny marked an important era in the history of the cotton manufacture.

The enormous productiveness of the spinning machinery could never have been utilised, had the conversion of the yarn into the woven fabric depended on the hand-loom weaver. It needed another important element to complete the series of automatic machinery, and this was supplied by Cartwright, who, in 1784, invented the germ of the power loom. In 1787 he completed his invention and erected a factory, which, probably by reason of his want of business habits, was not successful as a pecuniary investment. Numerous subsequent improvements were made by Bell, Monteith, Horrocks, Sharp, and Roberts, and a host of other inventors, who have improved this machine until it may be said to be perfectly self-acting in all its operations.

Having thus briefly glanced at the successive steps by which the inventive genius of the last century supplied the mechanism, we will now, with similar brevity, examine the industrial structure which capital has raised with the tools thus placed within its reach.

About the time Crompton completed his invention, he received 14*s*. sterling per lb. for spinning and preparing number 40 yarn, and shortly afterwards he was paid 25*s*. sterling for number 60. To show how fine a grist he could spin, he produced yarns as fine as number 80, for which he obtained 42*s*. per lb. More perfect mechanism and improved skill enabled the spinners to work still finer grists for lower prices, and in 1793, only 8*d*. sterling per lb. was paid for

number 100. Notwithstanding, however, this extraordinary diminution of price, by aid of the improved machinery, superior judgment in the selection of suitable cotton wool, and greater skill in working, the spinners can with less labour earn more money than they did when the prices were high.

Nor is the saving effected by the power loom in weaving of much less importance than that due to the spinning machinery. The invention of the fly shuttle by John Kaye, doubled the productive power of the hand loom; but even as compared with the loom in this improved state, the mechanism wherewith a girl is enabled to produce from 300 to 400 yards of four-fifths cloth per week, is as great an economical triumph as is the invention of the spinning frames that produce the yarn.

Applying the great saving in the details of the cost of production to the quantities annually worked up, we have the key to the wonderful expansion of this branch of industry, and we are enabled to understand the means whereby the manufacturer is enabled to place within reach of the multitude those fabrics that contribute so much to the civilisation with which we are surrounded.

We have alluded to the probable increase in the supply of raw material from regions which hitherto have not contributed at all, or only in a small degree, supplies of cotton to the manufacturer. It is well that these regions are so widely spread, and that they have a capacity to yield bountifully, for manufacturing power has increased, and, indeed, is still increasing at a rate which has no parallel in the records of industrial

enterprise. The quantity of cotton annually consumed by each spindle in the United Kingdom is 31¾ lbs.; and it is estimated by those best acquainted with the case, that in 1860 the rate of increase in the number of spindles was not less than 45,000 per week, representing an increase in the consumption of cotton of upwards of 74,000,000 lbs. per annum. As the average consumption of cotton per hand employed has been 2,351 lbs., this increase indicates an annual increase of 31,600 in the factory population of Britain. It is noteworthy that, notwithstanding this extraordinary increase in production, the supply of the manufactured article does not keep pace with the expansion of the markets, the scarcely perceptible reduction in price being entirely due to the steady improvement in the machinery used.

The following table will give some idea of the periodical increase of this branch of business and of the enormous values involved:—

Year.	lbs. of Cotton Wool Consumed.	Quantity and Value of Cotton Goods Exported from Great Britain. No. of lbs. of Cotton Yarn Exported.	No. of Yards of Woven Fabric Exported.	Value of Hosiery, Lace, &c, Exported.	Totl. Value of Cotton Goods Exprtd. from U. Kingdom.	Estimated Total Value of Cotton Goods Manufactured in Great Britain.	Average price per yard.	Average price of Yarn per lb.	Average price of bowed Cotton per lb.
				£	£	£	d.	d.	d.
1815	....	9,241,548	252,884,029	....	19,822,193	....	17¼	43⅜	21½
1820	....	23,032,325	350,956,501	....	16,035,643	....	9	29⅜	11½
1827	....	44,878,774	365,492,804	1,144,552	17,638,165	....	8½	18⅞	6½
1830	250,695,000	64,645,342	444,578,498	1,175,153	19,428,664	47,000,000	7⅜	15¼	6
1840	457,723,000	118,470,223	390,631,997	1,265,090	24,668,618	49,616,655	4 13/16	14⅜	6
1850	613,204,800	131,370,368	1,358,182,941	1,343,262	28,257,401	45,826,992	3 13/16	12¼	7¼
1860	1,140,510,168	197,364,947	2,775,450,905	1,795,590	52,013,482	92,013,482	3¼	12	7¼

We may add that, at the present time (1862) the total number of spindles employed in the cotton manufactures of Great Britain is estimated at nearly 36,000,000, and that the cotton industry of the rest of the world is assumed to be, collectively, equal to that of the United Kingdom.

We have the history of the rise and progress of the various branches of manufacture in the manufacturing districts of Great Britain to warrant us in the conclusion that priority of selection—other things being equal—exercises an enduring influence in permanently locating a particular branch of industry. We have noticed how Manchester early became the seat of the manufacture of textile fabrics, by reason of the encouragement given by the municipal authorities, and we have seen how that branch of industry has clung to the place of its birth through succeeding generations. Other instances might be cited. Glasgow was the genial birthplace of successful power-loom weaving, and still retains a pre-eminence in that branch. Nottingham was the refuge of the first promoters of the stocking frame, and of the subsequent inventors of bobbin-net lace manufacture, and, with the adjacent county of Derby, is still the chief seat of those industries. Undoubtedly, there were important considerations which influenced selection, and which could not be overruled by favours within the gift of localities. When power-spinning and weaving were first successfully introduced, sites otherwise inconvenient were selected which offered considerable water power. Watt relieved the cotton spinners from the necessity of seeking power at the

expense of other advantages—then the extensive employment of steam induced the establishment of factories where coal is abundant. The improvements that have been made in the steam engine, and the consequent economy of fuel, has rendered this consideration even of minor consequence: one ton of coal can now do as much work as three tons did some years ago. Notwithstanding, however, the opposing circumstances here mentioned, the early establishment of any branch of industry in a locality has exercised an important influence. How else shall we account for the eminence of Sheffield in cutlery, Birmingham in hardware, Bradford in worsted, and Leeds in the cloth trade?

As a measure of progress it is a striking fact that whilst in the year 1760, according to Dr. Percival, the entire Cotton Trade of Great Britain did not return, for materials and labour, more than £200,000, in 1860 the returns of our Cotton Manufacture were estimated by Mr. (now Sir T.) Bazley, M.P., at the sum of £85,000,000; and that whilst in 1764 the weight of raw cotton imported was 3,870,000 lbs., in 1860 the quantity of raw cotton consumed in this country was 1,083,600,000 lbs. The figures we have quoted above show that we have in this brief period increased by more than four hundred times the value of the cotton products, and that we are consuming in the operation two hundred and seventy times as much weight of raw cotton as was consumed a century ago. They also confirm the fact that, owing to the comfort and cheapness obtained by cotton for clothing and other purposes, these fabrics have become the most popular

among the masses of the people in all countries. And, lastly, they denote the prodigious increase of cotton cultivation, whereby the planters who produce this raw material, in the United States or elsewhere, have become possessed of a most lucrative industry. By way of illustrating the extent and perfection attained in the Cotton Manufacture, it has been stated that in this country we employ as many as 36,000,000 of spindles, and that in one minute we can spin a length of cotton yarn which would wind four times round the earth. Every day 10,000,000 yards of cotton fabrics come out of our looms; and it seems to baffle our power of calculation when we say that, after having supplied the wants of our own population most abundantly, we have 100,000,000 lbs. of yarn and 2,000,000,000 yards of plain and printed goods to spare, which we export to supply the wants of the people of other nations. With abundance of labour at our command, and by the use of economic appliances, the cost of production and the selling price of every article of cotton manufacture has been greatly reduced.

In the year 1786 the price of cotton yarn, number 42, was 10*s.* 11*d.* per lb.; in 1860, 11*d.* per lb. In the year 1786 the price of cotton yarn, number 100, was 38*s.* per lb.; in 1860, 2*s.* 6*d.* per lb.

In proof that an appreciable amount of the advantages of cheapness has reached the consumer, we may state that in the year 1790 the mother of an eminent manufacturer still living purchased a white cotton dress at 6*s.* a yard; while in 1860 the same quality of fabric was obtainable at from 2½*d.* to 3*d.* per yard. As

compared with fabrics of wool or flax the economy of cotton is very striking. Taking the cost prices as they existed in 1860, the relative value of the three fabrics was as follows:—A garment of 1 lb. weight, made of flannel, cost 3*s.* 1*d.*; of linen, 2*s.* 4*d.*; of cotton, 1*s.*

The Cotton Manufacture is no longer confined within the limits of the county of Lancaster, as at its commencement; it is now extensively carried on in parts of Yorkshire, in Cheshire, Derbyshire, Lanarkshire, and to some small extent in Ireland and in Wales. Lancashire is, however, still pre-eminently distinguished as the home of the cotton trade, and retains a sort of monopoly in the extent of its productive power.

According to a Parliamentary return issued in 1862, Lancashire possessed nearly 80 per cent. of the total number of factories of England and Wales.

	England and Wales.	Lancashire.	
No. of Factories	2,715 ...	1,979	or 72 per cent.
„ Spindles	28,352,125 ...	21,530,532	„ 75 „
„ Power looms...	368,125 ...	306,423	„ 83 „
„ Hands directly employed ...	407,598 ...	315,620	„ 77 „

Nearly 500,000 persons are thus directly occupied in this single industry; but to these must be added engineers, builders, machinists, bleachers, printers, and other auxiliaries. Since, however, the number of hands actually employed appears comparatively small for the results produced, it will be necessary to bear in mind that the greatest operators are the machinery and the steam engine. Other estimates

show that the entire number of persons directly employed in, or indirectly dependent upon, the cotton trade is about 4,000,000, or as much as 20 per cent. of the population of England and Wales. The importance of the cotton manufacture, in its individual character and in a national point of view, can only be estimated by comparing it with the various other branches of industry.

By reference to the Board of Trade tables of the exports of British and Irish produce and manufacture in 1860, we find that upwards of 40 per cent. of the total exports of the country consisted at that date of cotton goods exclusively; the three other textile branches having constituted 20 per cent.; whilst the remaining 40 per cent. consisted of all the other articles of commerce exported from this country.

EXPORTS.

TEXTILE—COTTON BRANCH.

Exports of cotton goods, yarn, hosiery and lace	£52,012,000	
Add to the above the proportion of two-thirds the value of haberdashery and slops	4,108,000	
		56,120,000

TEXTILE—OTHER BRANCHES.

Woollen goods, hosiery and yarn	£16,000,000	
Linen goods, lace, thread and yarn	6,606,000	
Silk goods, thrown silk and yarn	2,413,000	
Add proportion of one-third of haberdashery and slops	2,054,000	
		27,073,000
Carried forward		£83,193,000

Brought forward £83,193,000

VARIOUS MANUFACTURES.

Beer, boots, cabinet work, candles, cordage, earthenware, glass, plate, leather, oil, paint, soap, soda, spirits, stationery, sugar, &c., &c.............. £12,158,000

NATURAL AND WROUGHT-UP PRODUCTS.

Coals, copper, hardware, iron, lead, tin, salt, steam engines, mill-work, machinery, &c., &c. £29,000,000

NATURAL PRODUCTS AND VARIOUS OTHER ARTICLES.

Butter, cheese, wool, fish, pickles, and many other articles not enumerated £11,540,000

52,698,000

Total value of Exports of all kinds in 1860...£135,891,000

It will be observed from this statement how large has been the contribution of the Cotton Manufacture to the entire sum of our exports, and how marked must be the effect of its influence on the commercial prosperity of the kingdom.

From the latest official returns on Factories and Workshops, on the motion of Mr. E. Baines ordered to be printed in August, 1871, it appears that the following were the statistics of the Cotton Factories in the United Kingdom :—

	England.	Scotland.	Ireland.	Total.
Spinning Factories	1,085	20	3	1,108
Weaving	649	36	8	693
Spinning and Weaving	513	17	2	532
Other Factories	124	25	1	150
Total	2,371	98	14	2,483

The number of carding machines in these factories was 65,960; of combing machines, 1,906; of spinning spindles, 32,749,743 running, and 1,945,478 standing; of doubling spindles there were 3,291,749 running, and 231,788 standing; of power looms, 405,122 running, and 35,554 standing. The number of power-loom weavers was 165,341. The moving power employed was 300,480 horse power steam and 8,390 water. The number of persons engaged in the factories was 449,087, of whom 271,690 were females.

THE WOOLLEN MANUFACTURE.

THE WOOLS OF COMMERCE, AND THE INFORMATION TO BE OBTAINED THEREON.*

The Wool Series—the second of our great staples—is one of the most important raw materials of our commerce, since the imports of wool average some 360,000 bales yearly (in 1854, 106,000,000 lbs.) Our home clip of wool is further about 200,000,000 lbs., and the value of the woollen manufactures exported (exclusive of home consumption) nearly £10,000,000 sterling.

Without entering further into the statistics of the trade, which has already been fully gone into by Mr. Henry Forbes, before this Society, by Mr. Thomas Southey, and others—without touching upon the immense extension of sheep and increased production of wool in the Cape Colony, Australia, and South America —without going into particular descriptions of the Alpaca, the Angora goat, and ordinary goat's wool—I shall content myself with entering somewhat fully into the practical detail of the qualities of sheep's wool, the points to be studied, and the information to be gleaned from an examination of the results of experience and

* Published in the "Journal of the Society of Arts," vol. iii, p. 677, August, 1855.

judgment in the chief wool-growing countries. Of course, any such remarks must necessarily be discursive and general, both from the large field to be traversed, and the channel through which they have to appear—the objects aimed at by the Society of Arts being rather the promotion of mechanical and practical improvement than agricultural and pastoral occupations.

The sheep, perhaps, of all domestic animals, except the dog, is most easily modified in its form, size, quality of fleece, and other properties, to suit it to various situations and purposes for which it is intended by man. We have, accordingly, at one end of the scale, the coarse wool of the Leicester, Cotswold, and other long-woolled breeds, furnishing what is called by manufacturers "combing" wool, and employed in making blankets, rugs, and coarse worsted goods, chiefly in Yorkshire and in Scotland; at the other end of the scale we have the short fine wool of the Merino sheep, fitted for spinning into the finest threads, of which the most beautiful superfine cloth is manufactured in the West of England.

Upon examining these two classes of wools under the microscope, a further and very curious difference is observed, viz., that whereas the fibres of the combing wools are mostly round and smooth, those of the clothing wools are jagged or imbricated at the sides. There are intermediate qualities adapted either for combing or clothing, but this last-mentioned property is essential in a wool intended for the manufacture of cloth, the threads of which require to be felted together in the fulling mill, by which a closer texture is pro-

duced than could ever result from separate threads, however closely they may be woven together.*

Corresponding to the varieties of fleece possessed by different breeds of sheep, there are varieties in the form and size of the carcase, and in the disposition of the animal. Whilst some breeds are adapted to rich and succulent lowland pastures, and are of a quiet and lazy disposition, inclined to fatten at an early age, but of tender constitution, others are suited to pick up a living by travelling over a wider range, and to endure the rigours of exposed hills and mountains.

Now, it will be evident that in introducing a breed of sheep into a new country it is of the utmost importance to select that one which experience has proved to be best adapted by its constitution and habits to the soil and climate in which it is desired that it should thrive. It would be as reasonable, for instance, to take a fat Leicester sheep from his sheltered and succulent pastures, and expose him on the bare short herbage to the sweeping blasts and snow storms of the Cheviot or the Lammermuir hills, as it would be to transport a city alderman to the backwoods, and bid him get his own living with the rifle of the American Indian.

The progress made in sheep farming in various countries—the comparative increase in the weight and profits on wool—the modes of tending, shearing, washing the fleece, baling, taking to market, relative

* See an interesting Article by Mr. N. Burgess, an experienced wool broker, in the "Journal of the Quekett Microscopical Club," for 1868, p. 23, on "The Wools of Commerce, Commercially and Microscopically considered."

yield of wool, modes of boiling down the carcase and steaming for tallow, all these points are deserving of notice and attention, and reliable information upon them would be of great interest to many.

The Americans, who are always ingenious in overcoming difficulties, have recently been adopting india-rubber cotton floaters for enveloping and packing bales of cotton, a number of which, thus united and enclosed, are floated down shallow rivers, when the stream is too low to be navigated by boats or steamers. One of these gum-elastic wrappers costs about £2 10*s.*; two or three bales of cotton on a raft only draw about a foot. Might not this plan be worthy of trial on the Murrumbidgee, the Lachlan, the Darling, and other tributaries of the Murray river in Australia, where the wool could be thus forwarded from the distant inland sheep stations to the shipping port with great economy; and the point is also worth the attention of the Dutch Boers on the Orange river in Africa, and perhaps of some of the settlers on the tributaries of the River Plate, and the interior rivers of South America.

Our Society has already directed great attention to the production and improvement of wool, and to an investigation of the progress of wool manufactures. Indeed, it is a source of satisfaction to know that the various subjects discussed, and the information elicited through its "Transactions," its premium lists, its lectures, discussion meetings, and "Journal," have resulted in great benefit to the arts and commerce, and originated many important productive and manufacturing improvements.

It is both instructive and gratifying to find the high

price of wool, occasioned by the increased demand for manufactures in France, Germany, and America, forcing a part of mankind back, as it were, to the most primitive pursuits, and the successful prosecution of trade stimulating the cultivation of the land in new and distant countries. The produce of our flocks at home, for want of correct agricultural statistics, can only roughly be computed by estimate, but the imports from abroad are clearly ascertainable from the trade returns.* The demand for wool is fast becoming greater than the annual supply, and to our own agriculturists we must look, as well as to our own colonies and foreigners, for an increase.

As in tillage land the same acre of ground may be made to produce from 30 to 50 per cent. more than its usual yield, by the aid of fertilisers, so may a flock of sheep be made to shear from 30 to 50 per cent. more of wool by adapting their food to the especial formation and growth of wool. One of the constituent parts of wool is albumen, hence those cereals which contain the largest percentage of it make the most wool when fed to sheep. Wheat and rye contain large proportions, peas and beans 29 per cent., oats only 10½ per cent.

It has been ascertained by actual experiment that the following are the results of feeding different kinds of roots and grains for the production of wool :—

1,000lbs. of	Potatoes, raw, with salt,	make	6½lbs.	of wool.
Ditto	Mangold Wurtzel, raw	„	5¼	„
Ditto	Wheat......................	„	14	„

* Since this was written official annual agricultural returns are issued.

1,000lbs. of	Oats	make	10lbs.	of wool.
Ditto	Rye, with salt	„	14	„
Ditto	Rye, without salt	„	12½	„
Ditto	Barley	„	12½	„
Ditto	Peas	..	16½	„
Ditto	Buckwheat	„	10	„

These results show that peas, wheat, and rye, produce the greatest increase of wool, and give about twice the number of pounds of wool that roots do in equal weight. Indian-corn meal, oil-cake, and such gross substances, are the proper feed when fat mutton and tallow are the objects; but the careful flock-master, whose main object is the wool, must rely on good hay and water, and a daily moderate allowance of those grains, with some potatoes or carrots as green food, for the attainment of his object, viz., the greatest amount of good wool, and that in the very best condition.

The points to be treated, as respects the quality of wools, were thus defined by the Jurors of the Great Exhibition, 1851 :—" The fineness and elasticity of the fibre; the degrees of imbrication of the scaled surface of the fibre as shown by the microscope; the quantity of fibre developed in a given space of the fleece; the comparative freedom of the fleece from extraneous matters; and the skill and care employed in preparatory processes, such, for example, as that termed "scouring" the fleece, upon which depends its liability, or otherwise, to mat at the bottom of the staple."

The qualities most valuable in regard to the fleece are thus pointed out by a colonial correspondent of great experience and judgment:—1. Fineness. 2.

Fullness. 3. Freeness. 4. Soundness. 5. Length. 6. Softness.

1. Fineness of the fibre of the wool can be judged of by practice when a lock of it is laid on the cuff of a coat of a dark colour. A deficiency in this quality will show itself by an abrupt falling off in fineness either in the neck or breech of the animal, or in both. The difference in fineness between these parts and the rest of the fleece should be so gradual as to be almost imperceptible. The settler cannot exert himself too much to breed close up, as it is called (*i.e.*, to make the whole fleece as nearly as possible equal throughout), otherwise the character of his flock as good breed will never be established, and the wool will invariably prove bad in the manufacture. No hair must be anywhere visible on the animal, especially under the fore-legs.

2. Fullness means the closeness with which the staples or locks of wool grow together on the skin. Upon opening the wool of a sheep possessing this quality in perfection, only a thin line of skin, as fine as a pencil-stroke, will appear round each staple, but, if deficient, a space almost bare. This is a point in which the Australian sheep are generally deficient, and of course the weight of the fleece suffers most materially. Some of the German sheep have great rolls or puckers of skin under their necks and on other parts, which give them a singular appearance, but the extent of wool-bearing surface is thereby increased.

3. Freeness means that the separate staples, or locks of wool, and also the separate fibres of each staple, are distinct, and by no means entangled together, or what

is called "smushy," like cotton wool. A deficiency in this quality shows itself most plainly along the ridge of the back. In a well-bred sheep the wool, on being opened, should fall apart under the hands as clear and broken as the leaves of a book. A want of knowledge of this quality has caused infinite mischief in Australia from people having mistaken an absence of freeness for fullness or closeness of growth, which I have already explained.

4. Soundness, or strength of fibre, is a quality in which New Zealand wool, like its native flax, is said to be pre-eminent. Along the ridge of the back there is a sort of division between the wool of each side. Tenderness, *i.e.*, deficiency in soundness, invariably shows itself there. Take out a staple from this part, and give it a strong steady pull, holding one end in each hand. If this proves sound, depend upon it that the whole fleece is so too. This is an indispensable quality in a combing wool, such as New Zealand is fitted to produce, as the process of combing tries the soundness especially. It is one also in which the Australian wool is liable to be deficient, arising from a check to the growth of the wool from the sheep having been half-starved by drought, an affliction to which those colonies are so often liable. For though the wool begins to grow again as soon as the sheep recovers his flesh, there is always a weak place in that year's clip at the point where the growth recommenced, by which it is materially damaged, for combing purposes at least.

5. Length of fibre must be carefully regulated by the nature of the pasture and climate; for any, the

least, excess will cause a proportionate deficiency in soundness, by which the wool will be depreciated for clothing, and rendered utterly useless for combing. If the length of the wool be too great for the nature of the country, it will be known by the twisting of the wool into hard bands, like pieces of twine, which break almost like rotten thread. It is an error as mischievous as the short cottony wool, and cannot be too carefully avoided. To judge of the length of the staple in a fleece, the best part to examine is the division along the ridge of the back, as it is there usually somewhat shorter than in other parts.

6. Softness sufficiently explains itself. A want of this quality is most conspicuous between the points of the shoulders and up the neck.

There is an oily matter natural to the wool of merino sheep, an excess or deficiency of which is equally objectionable, but there seems to be no definite term to express the different kinds of oil, yolk, or gum, as they are alternately called. Probably those sheep should be chosen whose fleeces abound in what may be termed transparent oil within the fleece, which, flowing to the end of the staple, there forms a yolk or gum, which by combining with dust, gives the surface of the wool a dark look. There can be no doubt that this yolk preserves the fleece from dead ends, and the deleterious effects of stormy weather, that it greatly facilitates the growth of the wool, and much increases its strength, softness, and elasticity. Manufacturers, I believe, will be found to prefer a fleece well supplied with the yolk, after it has been thoroughly washed, to a dry fleece with dead ends, as they acknowledge that the wool

from oily sheep is manufactured with much less waste, is easier worked, and will make handsomer and more lasting cloth than the wool of sheep quite destitute of oil. But there is another kind of gummy matter, quite different in its appearance and effects from the above. This may be observed in yellow, thick, pitchy particles within the fleece, and does not circulate freely to the end of the wool, consequently the fleece has a light-coloured surface, with dead ends, and as the wool cannot be freed from this thick adhesive gum, by a common cold-water wash, such fleeces will show a larger percentage of shrinkage in cleansing than any others. The German fleeces are much fuller of yolk than the spout-washed Australian wool; on this account a considerable allowance of weight must be made when comparing the weight of the former with that of the best-conditioned flocks of Australia.

The weight of the fleece obtained from various kinds (both the maximum and the average), is a matter highly desirable to be known.

We have a great number of breeds in Great Britain, from the Shetland, yielding only about 1½ lbs. of fine cottony wool, and various short and long woolled sheep, ranging from 2 to 10 lbs. the fleece; but there are other breeds scattered over the globe, of the peculiar characteristics of which we know little.

Among the sheep peculiar to Turkey and Asia, and hitherto unknown in Europe, is a breed called the Karamanlia, generally met with in the neighbourhood of Broussa, where large flocks of them are bred, and where they are in high estimation for their flesh and their wool, but more particularly for their tails, which.

when boiled down, yield as much as 15 lbs. of excellent fat. This fat keeps good much longer than butter, and replaces it in case of need.

The Bengalee sheep is small, lank, and thin, and the colour of three-fourths of each flock is black or dark grey. The quality of the fleece is worse, if possible, than its colour; it is harsh, thin, and hairy in a very remarkable degree. The breed on the Coromandel coast is of a still more inferior quality, both in fleece and carcase. Their coarse hair and their incompact form, suggest an affinity to the goat or deer. Two or three may in some places be bought for a rupee (2*s.*), and yet are an unprofitable purchase.

There are in Bengal a few sheep with four horns, which are superior in size and better proportioned than the common kind. The Cabool sheep readily fatten; they have a large excrescence on the rump, far exceeding that of the Cape sheep; it is of a semicircular form, and nearly half as large as the whole body. The fleece of the Indian sheep ordinarily weighs but half a pound. In Coimbatore there is a small compact breed of sheep, called the Curumbar, modelled very much like the Southdown, but on a reduced scale, and with a head shaped like the Merino. The animal fattens readily, and its flesh is close grained and well flavoured. The wool is thick and curly, and almost entirely free from hair. The fleece is generally white and the head black. The sheep are shorn twice a year.

Measures have lately been taken to improve the quality of the Punjaub wool, in which there is now a brisk export trade, *viâ* Kurrachee, including 30,000 to 40,000 maunds, of about 75 lbs. It has increased

about 90 per cent. over previous years. The wool-staplers of Khorasan, and the producers of wool on the hills north of Cabool, Ghuznee, and various parts of Central Asia, bring it down by caravans to the frontier, and as the navigation of the tributaries of the Indus become developed, a further increase of the produce brought down may be looked for.

It is impossible for a stranger to conceive the extreme care and attention paid to the production of fine wool in Germany, where immense flocks are reared for their wool alone, kept during the greater part of the year in large barns, and so carefully tended that neither dew nor rain is allowed to fall upon them. In the King of Saxony's flock wethers are kept to the age of nine or ten years, solely for the 2 lbs. of wool which they annually yield. If subjected to a varying temperature or checked perspiration, a knot is formed in the staple, which can be seen under a very strong magnifying power, and which very materially deteriorates from the value the Germans attach to the article. Next to equality, fineness of texture is the great desideratum, and a beautiful machine has been invented by Mr. Jeppe, of Rostock, for the admeasurement of the thickness of the wool, and the proof of its strength, which unites the accurate workmanship and delicacy of watchwork. By this instrument 100 hairs of each fleece, selected from nine different portions of the body, forming an average of fineness, are subjected to a given pressure, which is registered on a very minute index. The result of one experiment was that an Austrian fleece had been produced of which twelve hairs only equalled in thickness one Leicester!

In the Museum at Stuttgardt there are said to be samples of every wool in the known world, comprising those even of our most recently-established colonies, carefully washed, weighed, and sorted, with such descriptive remarks appended as are necessary to illustrate the subject.

So important is the proper selection of breeding animals considered in Germany that the best flockmasters there do not trust to their own judgment, or that of their shepherds, but employ persons called "sheep classifiers," who make it their special business to attend to this part of the management of several flocks, and thus to preserve, or, if possible, to improve, the best qualities of both parents in the lambs.

The ordinary flocks in Saxony produce very fine wool, but much less in quantity than those of the improved breed; the first yielding from 2 to 2¼ lbs., worth from 2*s.* 6*d.* to 3*s.* 6*d.* per lb., whilst the flocks of M. Gadegast, and a few others, yield from 2½ to 3¾ lbs., worth from 3*s.* 6*d.* to 4*s.* 4*d.* per lb. Thus whilst the yield of an ordinary sheep of the country would be worth on an average 6*s.* per annum, the yield of an improved sheep would be as much as 10*s.* a year. This large difference in the produce of each sheep in a flock of some thousands would of course amount to something well worth the extra care and expense.

There are flocks of the Negretti breed in Mecklenburgh and Pomerania of undoubted blood, which average 4 lbs. per fleece, worth 3*s.* 6*d.* per lb., and many rams are to be found yielding from 8 to 10 lbs. of washed wool. This weight is also often reached in the Cape Colony and in America.

The Merino race ought as much as possible to be kept pure in France; and the flesh of the French breed of sheep would be improved for food by a cross with the English breed.

M. de Lavergne, a recent French writer, from careful enquiries, estimates the number of sheep in France and the United Kingdom severally at 35,000,000, but while the English sheep are supported upon 77,000,000 acres, those of France live upon 132,000,000.* Scotland, in spite of all her endeavours, can maintain only about 5,000,000 sheep, and Ireland, which from its pasture ought to rival England, reckons at most only

* The following are the latest returns up to 1870 of sheep in the United Kingdom, her principal colonies, and in various Foreign Countries:—

United Kingdom	31,403,500
The Australian Colonies	51,294,241
South African Colonies	10,168,997
North American Colonies	2,434,689
Russia	45,130,000
Sweden and Norway	3,244,473
Denmark	1,875,052
Prussia	22,262,087
Wurtemburg	656,000
Bavaria	2,040,000
Saxony	304,000
Holland and Belgium	1,513,004
France	30,386,233
Portugal	2,717,049
Spain	22,054,967
Italy	11,040,339
Austria	20,103,395
Switzerland	445,400
Greece	2,539,538
United States	40,853,000

3,000,000, upon 200,000,000 acres. [The number of sheep in 1871 was, in Scotland, 6,882,000 and in Ireland, 4,238,000.]

Estimating the value of our flocks, we shall find:—

35,000,000 sheep at, say 25*s.* average, worth	£43,750,000
The fleece, at a low average of 4 lbs., say at 10*d.* the lb....................................	5,833,333
Total............	£49,583,333

The average return of an English sheep farm is fully six times greater than a French one.

In Canada the number of sheep, in round numbers, is 1,600,000, and the average weight of the fleece 2 lbs. 10 ozs. The increase of wool there in nine years has been 64 per cent., and that of sheep 33 per cent., showing an improvement in the weight of the fleece of not far from 30 per cent. The proportion to population in the United States and Canada is about the same, nine sheep to every ten inhabitants.

About one-fourth of the French sheep of the present day consists of Merinos and half-Merinos, the rest have at the same time improved both in carcase and wool, simply by means of more skill in their management.

England has proportionately three times more sheep than France. To this numerical difference has to be added a no less important difference in quality; and the reason for this is, that in France wool has been looked upon as the principal product, and meat the accessory; in England, on the contrary, the wool has been looked upon as the accessory, and meat as the chief production. About 10,000,000 head of sheep are slaughtered annually in the British Isles—of which

8,000,000 belong to England alone—yielding, at the average weight of 80 lbs. of nett meat, 800,000,000 lbs. In France there are about 8,000,000 slaughtered, which at the average weight of 40 lbs. nett meat, equal to one-half the weight of the English sheep, gives 320,000,000 lbs. So that while the 35,000,000 of French sheep are equal in wool to the same number of sheep in England, they are deficient in meat in the proportion of one-half.*

The Americans, although importing wool largely for their manufactures, are, nevertheless, paying great attention to the increased weight of the fleece on their sheep. While the number of sheep between the two last decennial censuses increased but 20 per cent., the aggregate weight of the fleece was augmented 46 per cent. In 1840 there were 19,311,374 sheep, yielding 35,802,114 lbs. of wool, equal to but $1\frac{84}{100}$ lbs. per head. In 1850 the average weight of each fleece was $2\frac{42}{100}$ lbs., from which it would appear that such an improvement had taken place in the various breeds of the American sheep as to increase their average product about 32 per cent. throughout the United States; and a critical examination of the returns of sheep and wool proves not only that the breeds are capable of much improvement, but that improvements are steadily taking place. The Americans, indeed, assert that they can outrival the world in wool as in cotton. For while Spanish sheep, yielding naturally wool 2,000 lines to the inch, carried to England, degenerated to 900

* These remarks, published more than fifteen years ago, must be qualified by the later statistics of sheep at the present time.

to the inch, when brought to the United States, they recovered to 2,100, a finer class of wool than the original.

The woollen fabrics used in the United States according to the Secretary of State's last Report, consumed 300,000,000 lbs. of wool, of which in 1853, 60,000,000 lbs. were raised in the country, 21,000,000 lbs. imported in the raw state, and 119,000,000 lbs. imported in manufactured fabrics. In the year ending 1853, 3,669 sheep and 216,472 lbs. of wool were exported from the States. The high price of wool and mutton has given an increased impetus to sheep husbandry in America. Texas is destined to be a great sheep as well as stock-raising State. The average price of wool in America for ten years previous to 1853 was 28 cents (14*d.*) per lb.; in 1853 it rose in Pennsylvania to 40 cents., and in Ohio to 50 cents.

In Norfolk, the average price of half-bred Down and Leicester hogget-wool for 32 years ending with 1853 was 39*s.* 3½*d.* per tod of 28 lbs. The highest point reached was 60*s.*, in 1834; the lowest, 24*s.*, in 1848.

WOOL AND THE WOOLLEN TRADE.*

"It should never be forgotten," observes Mr. Thomas Southey, one of the most experienced of the wool brokers, "that sheep's wool is the second staple of British manufacture, and that—with the expansive industry and increased consumption at home, coupled with the progressive demand abroad for textures made with it, and even for the raw material itself, upon the

* Published in the "Merchants' Magazine," June, 1852.

Continent, of which our ports have now become a kind of entrepôt—adequate supplies are absolutely necessary. Upon these the bread of many thousand families depends, besides a commensurate remuneration to the capitalists and manufacturers who employ them. The woollen manufactures form a most important item of British industry; for the value of the various woollen and worsted fabrics and yarn, which we exported last year (1851), was close upon £10,000,000 sterling."

The following table exhibits the progress that has been made, both in the colonial produce and the wool trade generally. The figures show the annual averages for five years, and represent so many millions of pounds weight.

Annual Averages of Five Years.	Foreign Wool.	Colonial Wool.	Total Importations.
1826 to 30	25	2	27
1831 „ 35	34	4	38
1836 „ 40	44	10	54
1841 „ 45	36	22	58
1846 „ 50	30	39	69

The annexed figures mark the progressive increase in our imports of wool, during the first half of the present century, in decennial periods :—

Years.	Bales.
1796	17,244
1801	34,668
1811	24,206
1821	62,252
1831	97,371
1841	219,003
1851	317,881

If we average these bales at $2\frac{1}{2}$ cwts. each, which is pretty near the mark, we shall find that while in 1796 we received but 4,828,320 lbs. of foreign wool, in 1851 we imported 89,006,680 lbs., and this, added to about 275,000,000 lbs. of home-grown wool, places annually at our command the enormous quantity of 364,000,000 lbs.; which is just about half the amount of cotton wool we work up.

Our Colonial wools are now derived almost solely from three regions of the world—India, Southern Africa, and Australia, including in the latter territory the islands of Van Diemen's Land and New Zealand. Australia now furnishes nearly the half of all our imports, and promises, in this respect, to be still more important in her prospective than in her present position in the comparative scale, if the injurious consequences likely to arise from the present gold discoveries can be averted. The open, grassy and pastoral character of her boundless territory, the mildness and salubrity of the climate, and the slight obstruction offered by the handful of her aboriginal population, are all circumstances that favour the present rapid development of her resources. Her distance from the mother country and her scarcity of labour must always, to some extent, restrain this natural progression. At the Cape, but more particularly in India, native labour is rendered available; in Australia, this has never been the case, excepting in a few individual instances.

We received no wool from India till 1833; when the importation was but 3,721 lbs.; in 1841 we received 3,008,664 lbs.; and British India now sends us over 4,000,000 lbs.

In 1826, we received only 1,250,000 lbs. of wool, from our own Possessions; in 1841, they supplied us with 16,500,000 lbs. In 1831, the total quantity of sheep and lamb's wool imported from all parts was 31,652,020 lbs.; in 1841, it amounted to 56,179,641 lbs.; and in 1851, it had reached 81,068,679 lbs.

From a tabular statement of the imports of sheep's wool (including goat's, &c.) into the British ports, in the four years ending 1851, it appears that the total number of bales imported from all parts of the world was, in 1848, 273,037; in 1849, 285,190; in 1850, 278,022; and in 1851, 307,085.

Thus, the imports of 1850 exceeded those of 1848, by more than 5,000 bales, and fell short of those of 1849, by more than 7,000; or, at the rate of 2½ per cent. Whilst the import of 1851, increased over the previous year by 29,063 bales.

The importance to us of our Colonial supplies will appear more striking, if we compare the imports from the Australasian colonies with those of Germany and other places.

	1848.	1849.	1850.	1851.
Germany.........	48,478	45,839	30,491	26,514
Sundry............	113,618	113,619	108,852	136,191
	162,096	159,458	139,343	162,705
Australia	110,941	125,732	138,679	144,320
Total bales .	273,037	285,190	278,022	307,025

From this we see that the imports from Germany fell off largely in the last three years; whilst those from Australia, show a considerable advance, for from thence we now draw nearly one-half of our supplies.

Increase from Australia.			Decrease from all other Places.	
Years.	Bales.	Per Cent.	Bales.	Per Cent.
1849 above 1848 ...	14,791 =	13·3 below	2,638 =	1·6
1850 „ 1849 ...	12,947 =	10·3 „	20,115 =	12·5
1850 „ 1848 ...	27,738 =	25·0 „	22,753 =	14·0

Here are results most remarkable. Whilst, during the two years ending 1850, the quantity of wool imported from other places had fallen off at the rate of 14 per cent., the quantity imported from Australia had advanced in the immense ratio of one-fourth!

The percentage proportion which the imports from Australia bear to the whole quantity imported, is worth noticing—

	1848.	1849.	1850.	1851.
Australia	40·6	44·1	49·9	47·0
All other places	59·4	55·9	50·1	53·0
	100	100	100	100

In 1806, we imported but one bale of wool from Australia; in 1850, we derived three-fourths of our colonial supplies from New South Wales and Port Phillip alone.

In 1846, we received nearly 22,000,000 lbs. of wool from our Australasian settlements, in the following proportions. viz. :—from

New South Wales	lbs.	16,363,158
Van Diemen's Land	„	3,589,076
South Australia	„	1,472,769
Western Australia..............................	„	340,267
New Zealand	„	24,076
	lbs.	21,789,346
At 1*s*. 6*d*. per lb. worth		£1,634,194

The rate at which the production of wool has increased in the colony of New South Wales, from 1825 to the present time, is as follows:—

	Average Export per Annum.	Ratio per head.
	lbs.	lbs.
1825 to 1829	640,000	12
1830 „ 1834	1,559,000	28
1835 „ 1839	4,965,000	56
1840 „ 1844	10,535,000	67
1845 „ 1849	21,431,000	102

There is little doubt that, but for the abstraction of labour from the sheep pastures, in consequence of the gold mania, the aggregate exports from New South Wales and Victoria, during the five years from 1850 to 1854, would have shown an average of about 50,000,000 lbs. annually; and in 1860 the yield will probably have exceeded 100,000,000 lbs., worth £7,500,000.

England can now import wool from Australia, a distance of 16,000 miles, as cheaply as from Hamburgh, distant but 160 miles, and the immense number of emigrant ships which will have to ship return cargo, will still further cheapen the freight on wool.

In 1810 New South Wales had 25,888 sheep. In 1846 there were 7,000,000 sheep in New South Wales and Port Phillip, and they were found to increase at the rate of 20 per cent.

In 1849 the number in all Australia was 15,087,903, distributed as under:—

New South Wales and Port Phillip	12,102,540
South Australia	1,088,400
Western Australia	144,000
Van Diemen's Land	1,752,963

In 1870 the number of sheep in the Australasian colonies was returned as follows:—

New South Wales	15,080,625
Queensland	8,921.714
Victoria	9,923,663
Western Australia	648,683
South Australia	4,400,655
Tasmania	1,531,187
New Zealand	8,418,569
Total	48,925,096

The weight of the fleece averages 2½ lbs., but sometimes reaches 2¾ lbs., which taken at 1*s.* 3*d.* per lb., every sheep yields annually 3*s.* worth of wool; the usual calculation is a net profit of £100 per annum from a thousand sheep, exclusive of the carcass.

In the Australian colonies, owing to the vast increase of the sheep and the difficulty of obtaining labour, the flock-masters have been obliged to reduce their flocks, by converting them into tallow.

In 1842 the boiling-down establishments in Australia were 47; and the sheep slaughtered in that year, for melting, 217,797; and horned cattle, 20,148; producing 48,758 cwts. of tallow. In 1849 the boiling-down establishments had doubled, being 96; the sheep slaughtered in that year were 743,513, and horned cattle 45,050, yielding 160,099 cwts. of tallow. From 1844 to 1849, both inclusive, the number of sheep slaughtered in New South Wales and Port Phillip was 1,565,752, and horned cattle 184,064, producing 440,186 cwts. of tallow.

At one establishment near Sydney (the Argyle), in 1850, the following was the result of 4,032 sheep, the property of W. Bradley, Esq. :—

624 toothless Sheep gave each	lbs.	16½
567 „	„	17¼
376 Rams	„	13¼
1,029 Ewes	„	22½
778 Wethers	„	25½
598 „	„	24½

Averaging nearly 20 lbs. of tallow each sheep.

The relative supplies of wool from each of the Australasian colonies in 1850 and 1851 were as under :—

	1850. Bales.	Proportion.	1851. Bales.
Sydney	51,463	37·1	48,564
Port Phillip	35,378	39·9	63,427
New South Wales	106,841	77·0	111,991
South Australia	11,822	8·5	12,268
Van Diemen's Land	17,468	12·6	17,278
Western Australia and New Zealand	2,548	1·9	2,783
Total	138,679	100	144,320

So that, of the total quantity imported from Australia, more than three-fourths came from New South Wales.

The rapidity of increase in the export of Australian wool will readily be seen by the following short statement :—

1816	lbs.	13,611
1821	„	175,433
1831	„	2,541,205
1841	„	12,399,090
1851	„	46,492,520

[The imports into the United Kingdom were, in 1861, 68,506,000 lbs.; in 1871, 182,753,585 lbs.]

According to the "Sydney Herald" the clip of 1851 fell below the amount of the preceding year by 1,500 bales—whether owing to lightness of fleece, or boiling-down establishments, does not appear. It may perhaps be accounted for by the difficulty and lateness in shearing, for the computation of the exports from New South Wales ends the 30th of October. The returns give upwards of 48,000 bales as exported. If we take 50,000 bales as the estimate, it will be worth about £1,250,000; tallow and hides may be reckoned at £100,000 more. This sudden augmentation of the resources of the colony—from which, however, is to be subtracted the enhanced cost of labour imposed upon the other avocations and industrial pursuits of the colony, as well as the previous value of the labour that has been withdrawn to the diggings—cannot fail to have, in the course of a brief period, a most important effect upon the value of property. At present the sheep farmer suffers more than he will gain from any enhanced value which his stock may have acquired in the market. The price of labour is higher, and gold has now become so staple an article of export, as in some degree to supersede wool for a remittance; in consequence of which, bills on England with the hypothecation of the produce, cannot be negotiated

at less than 6 per cent., which formerly sold at par. This loss falls on the producer. The value of produce is of course proportionably diminished.

There is a great improvement recently in the character of the Australian wools. The principal objection to it formerly was the burr, and as this has so often been pointed out, growers will no doubt take care to guard against it as much as possible.

The wools from the western and southern ports still reach England in very bad order, while from Port Phillip, Portland Bay, and Van Diemen's Land, they come to hand in sound merchantable condition.

This arises from three causes—1st, the quantity and size of the bags used; 2nd, from the mode of pressing them before shipment; and 3rd, (in some cases) from much screwing on board ship. As respects the bags, it is observed by experienced brokers that too much care cannot be taken to secure them of good material, which will admit of the bales being press-packed, without breaking; the size best adapted is 4 feet 9 inches in length. When packed, these bales measure about 3 feet 6 inches, being lapped over at one end. Nearly all the wools from Port Phillip and Van Diemen's Land are packed thus. With regard to the pressing of bales before shipment, we may remark that when pressed from the sides, as is usually the case at Swan River and Port Adelaide, the bags almost invariably burst at the ends, however strong they may be; while those from other ports are pressed from the ends without bursting, forming almost square packages, which reach England nearly as sound as when shipped, except in cases of sea

damage, which is in a great measure obviated by good packing. The advantage of this latter mode to the shipper, is obvious, as it secures to him both the quantity and the quality of the wool shipped, which can never be the case when bales are delivered in a torn and broken state, with loose wool and rubbish indiscriminately stuffed into them during the discharge of the ship. The practice has been gaining ground of making the bales larger. Formerly the average weight of the bales was a little over 2 cwts.; now, it is about 3 cwts.

From the Cape Colony we derive our next largest supply—5,250,000 lbs. Cape wools have not hitherto met with that attention which they have deserved. A proper discrimination between the superior clips and the inferior has seldom been practised; and this staple export, although for some years steadily advancing in quality as well as in quantity, has continued to suffer, like the Cape wine, from its unfortunate name. At the local show of articles from the Cape, intended for the Great Exhibition of 1851, two bales of wool received prizes of £15 and £10, respectively, and these, when afterwards put up at auction, in London, realised 2*s*. 3*d*. and 3*s*. per lb.—an evident proof that superior wool will always fetch the best prices from our brokers, from whatever quarter it may come.

From the Cape Colony the imports in 1831, were 47,868 lbs. only; in the next two years they increased more than twenty-three-fold, and we now receive 5,250,000 lbs. from thence. The Cape wools are much more carefully got up than formerly, and are likely to become a favourite article.

There were in the Cape Colony, in 1849, 4,700,000 sheep, distributed as follows:—

	Spanish Sheep.	African Sheep.
Western Province	451,449	412,449
Eastern Province	1,917,641	1,921,009
Total...........	2,369,090	2,333,458

The African sheep were valued at 6*s.* 9*d.* to 7*s.* 6*d.* each; the Spanish at 10*s.* 6*d.* to 13*s.* 6*d.* [In 1866 there were 9,836,065 sheep in the Cape Colony.]

The following return shows the increase in the imports of wool since 1833, and may help to convince the financial economists that the Cape Colony is, in itself, worth something to a country which supplies half the world with woollen manufactures.

	Cape Town.	Port Elizabeth.	Totals.
1833 ...	lbs. 73,324 ...	lbs. 39 753 ...	113,077
1840 ...	„ 509,597 ...	„ 401,521 ...	911,118
1849 ...	„ 1,567,212 ...	„ 3,457,734 ...	5,024,946

[In 1871 we imported from our South African Colonies 32,643,785 lbs. of wool.]

Mr. Thomas Southey, in his recent supplementary work on Wool, goes into full details in order to ascertain, as nearly as possible, the number of sheep in the United Kingdom, and the average annual weight of shorn and skin wool, available for the purposes of the woollen and worsted trades. From careful enquiries in the best-informed quarters, he arrives at the result, that we annually clip 40,000,000 of sheep, whilst the fleeces of 15,000,000 more,

slaughtered, pass through the hands of the fell-mongers. The basis of the manufacture, then, would be about 275,000,000 lbs. of home-grown wools.

Our woollen manufacturers are fast losing their trade with the United States. The German, French, and Belgian manufacturers are taking the lead in fine cloths and kerseymeres; the Americans are superseding them in coarse and middling qualities of cloths and kerseymeres, and in mousseline-de-laine, flannels, blankets, carpets, &c. The United States census of 1840 gave the number of sheep in the Union at about 20,000,000, and the product of wool at 36,000,000 lbs. A very large proportion, probably over three-fourths, of these sheep, were fine-woolled, that is, improved by the Merino and Saxon blood sheep, and their wool, therefore, would be worth from 1*s*. to 2*s*. per lb. The census returns for 1850, estimated the capital invested in the woollen manufacture of the States, at 28,000,000 dollars, and it gives employment to 39,152 hands. Nearly 71,000,000 lbs. of wool are annually consumed, and the value of the product is over 43,200,000 dollars. The capital invested is only about one-third of the amount employed in the manufacture of cotton, in the United States; but the value of the product is more than two-thirds that of the cotton manufactures. The wool produced in the United States, in 1850, was 52,422,797 lbs.—that manufactured, 70,862,829 lbs.; showing a deficiency of production of 18,440,032 lbs.

The woollen manufacture is receiving, in America much more attention than formerly, and wool-growing is, in consequence, on the increase. The supply of

wool in the United States has been so much smaller than the demand, for the last seven or eight years, that the importation, which in 1844 was but 3,500,000 lbs., reached, in 1851, 18,609,000 lbs., valued at 1,681,000 dollars. The principal wool-growing States of the Union, are now (1851)—

Ohio	lbs.	10,089,607
New York	„	10,021,507
Pennsylvania	„	4,784,367
Vermont	„	3,492,087
Virginia	„	2,850,909
Indiana	„	2,502,763
Kentucky	„	2,246,168

These States raise more than two-thirds of the whole quantity.

The manufacturers of Boston and its vicinity, in their memorial to Congress, prior to 1843, stated the amount invested by woolgrowers of the United States to be 240,000,000 dollars; and Ex-Governor Slade, in Congress, 1842, said the whole amount invested in sheep had barely, in the States, exceeded 200,000,000 dollars. If we suppose the flocks to have increased 10 per cent. per annum, since 1840 the number of sheep in the United States would be 40,000,000 at least, in 1850, worth 80,000,000 dollars; and the last annual clip, which was 90,000,000 to 100,000,000 lbs. of wool, may be estimated at 30,000,000 to 35,000,000 dollars. The imports of wool have been decreasing in proportion to the local production. In 1844, the whole amount of wool imported, was 23,800,000 lbs.; in 1845, 28,800,000 lbs.; in 1849-50, according to the official tables of commerce and navigation, the

import of wool to the United States was something over 18,600,000 lbs. obtained from the following countries—

From the Argentine Republic (Buenos Ayres)	10,176,966
Turkey (including Morocco)	3,132,722
England	1,927,403
Chili	1,031,260
France (on the Mediterranean)	1,017,566
Canada	467,284
Brazil	374,206
Miscellaneous	541,272
Total......... lbs.	18,638,679

In 1840 Canada produced only 321,441 lbs. of wool, but, according to the foregoing return, a considerable increase has since taken place. The number of sheep, in the Province of Canada, in 1848, was about 1,500,000; of which 833,807 were in Upper Canada, and 602,821 in Lower Canada. [The number in the Dominion of Canada in 1862 was 2,399,799.]

In 1846 we imported 5,231 bales of Angora and Cashmere goats' wool; in 1850, the imports had more than doubled, having risen to 12,884 bales. This wool has come into extensive use, for making into light paletôts and over-coats, which have the properties of repelling wet; it is also made into plush coats and decorative laces, &c.

The wool from the South American States has increased from one or two bales, in the commencement of the century, to 49,038 bales in 1851. The Peruvian sheep and alpaca wool imported now ranges from 46,000 to 56,000 bales annually. In 1848, the quantity

of alpaca wool imported, rose to 1,521,370 lbs. of which 15,174 lbs. were re-exported to Holland, 19,000 lbs. to Belgium, and 300 lbs. to the Hanseatic Towns; the remainder being consumed in our own towns. In 1849, 1,655,800 lbs. were received, and 126,082 lbs. re-exported; in 1850, the imports were 1,652,295 lbs. [In 1870, they were 3,888,536 lbs.]

In 1836, alpaca wool became an important article of commerce, having been brought into extensive use by Mr. (now Sir) Titus Salt, of Bradford. Whilst in the five years, from 1836 to 1840, the exports averaged but 560,000 lbs. per annum, in 1851 they had risen to 2,186,480 lbs., and the price has advanced from 10*d.* in 1836, to 2*s.* 6*d.* per lb. in the present year (1851). The introduction of mohair or goat's wool, an article of similar properties and of extensive application for ladies' dresses, lining of carriages, &c. followed close upon this, and soon came into very general use—the exports having increased from 1,000,000 lbs. in 1841, to nearly 2,000,000 lbs. in 1851. [And 8,672,631 lbs. in 1871.]

Mr. Beaumont, in his "Travels in Buenos Ayres," says: "Sheep were formerly only regarded for their wool, and to save trouble the carcass was left to rot, or to be devoured by other animals, leaving the wool to be gathered at leisure. Even until lately I am assured that the flayed carcasses of sheep, dried in the sun, were piled up in stacks, for fuel, like firewood; the bricks and lime were burnt with these carcasses, and there is a law extant, to forbid, for the future, the practice of driving the sheep alive into the kilns, to

save the trouble of killing them previously." Threepence each was for many years about the current price for sheep; and, in 1825, 4,000 sheep were bought by the Rio la Plata Company, at *2s.* a head.

At the close of 1849, there were 875 factories in England and Wales engaged in spinning wool, of which 532 were in Yorkshire; these employed 784,054 spindles, giving occupation to 30,552 persons. The total number of woollen factories (spinning, weaving, &c.), were returned at 1,306; the spindles, at 1,356,691; power looms, 9,170—total persons employed 64,426. The return of worsted factories, was 493; the number of spindles, 864,874; and power looms 32,617 — employing 79,000 persons. The total number of factories in the worsted trade in 1850, was 501; of spindles, 875,830; of power looms, 32,617—and the moving power employed was equal to 11,515 horses.

In a lecture delivered in May, 1852, by Mr. Henry Forbes, of Bradford, before the Society of Arts, London, "On the Rise, Progress, and Present State of the Worsted, Mohair and Alpaca Manufactures of Great Britain," he estimated the yarn spun at about 57,000,000 lbs. weight per annum, which would require a consumption of 100,000,000 lbs. of fleece wool. Of this quantity, about 9 per cent. was long wool, and 16 per cent. short wool, extracted from the long in the process of combing, both of which were passed forwards for clothing or strictly woollen purposes. The remainder, 75,000,000 lbs., would be divided into—

60,000,000 lbs. English Sorted Wool at 1*s.* 2*d.* per lb.	£3,500,000
15,000,000 lbs. Colonial and Foreign at 1*s.* 9*d.* per lb.	1,312,500
Add other raw materials used in the manufacture, as	
Cotton, Silk, Dyewares, &c.	1,500,000
Direct Wages paid	3,000,000
Indirect Wages, as Rent, Wear and Tear of Machinery, Coals, Soap, Oil, Interest of Capital, &c., &c.	3,187,500
Total	£12,500,000

This he estimated to be distributed throughout the country in something like the following proportions :—

West Riding of Yorkshire, Goods and Yarns	£8,000,000
Lancashire, De Laines and other Light Fabrics	1,500,000
Leicestershire, Worsted Hosiery	1,200,000
Norwich Goods, Irish Stuffs, Devonshire Long Ells, &c.	1,300,000
Scotland — Worsted Stuffs (not including Shawls)	500,000
Total	£12,500,000

Of the goods thus produced a very large proportion was destined for foreign consumption. In the Trade and Navigation accounts there was then no proper classification made of the various fabrics produced from wool. The nearest approximation that could be made was to take from the returns of exports the following items, viz.,—

Stuffs, Woollen and Worsted, which in 1851 were	£3,819,755
Woollens and Cottons mixed	1,781,220
Worsted and Woollen Yarn	1,484,435
Worsted Hosiery	188,701
Total	£7,274,111

The exports, therefore, of worsted goods would appear to be about 50 per cent. on the total production, and one-tenth of the whole exports of the United Kingdom. They were chiefly sent to Germany and the United States of America. After deducting these exports, there would still remain for the whole female population of Great Britain and Ireland, from the infant in the nurse's arms to the "oldest female inhabitant," a dress of worsted stuff each year, seven yards in length.

To sum up the facts connected with this important subject; in 1820 the entire import of foreign wool into this country from all quarters was 9,775,000 lbs., of which only 99,415 lbs. was from Australia, the remainder consisting almost altogether of Spanish and German wools. In 1851 the quantity of wool imported had risen from 9,775,000 lbs. to no less than 81,063,000 lbs., of which the enormous quantity of 51,993,463 lbs. consisted of the production of British possessions out of Europe. Of this 51,993,463 lbs., more than 40,000,000 lbs. was the growth of the Australian colonies. The official accounts, giving the exact distribution of the imports of 1850, are sufficiently recent to show the great change which in a few years has taken place, not only in the quantity of wool imported, but also in the sources from which it has been derived, and more especially the great importance of Australia. For this purpose it will be sufficient to quote the imports at intervals of ten years. The following table shows the progress of the trade from 1820 to 1870:—

IMPORTS OF WOOL.

	1820.	1830.	1840.	1850.	1870.
	lbs.	lbs.	lbs.	lbs.	lbs.
Australia	99,415	1,967,309	9,721,243	39,018,000	175,081,427
South Africa..	13,869	33,407	751,741	5,709,000	32,785,271
India	8,056	—	2,441,370	3,473,000	11,143,148
Germany	5,113,442	26,073,882	21,812,664	10,500,000	54,276,417
Spain	3,536,229	1,641,773	1,266,905	489,000	
Total from all parts	9,775,000	32,265,000	49,436,000	74,326,000	319,511,[illegible]

Here, then, we have two remarkable facts established—first, the enormous production of wool in Australia; and second, that whereas in former times it formed but a small and unimportant portion of our entire foreign supply, it now represents nearly one-half of the whole. But the value of Australia to the woollen trade is not confined to the mere quantity of wool which it produces; its quality is in many respects quite as essential. For many branches of the trade it has become an absolute necessity.

OUR WOOL SUPPLIES.*

THE manufacturers are crying out for larger supplies of raw material. Wool is not so abundant in the market as could be wished, great as has been the progress of production in our colonies of late years. We have learnt to utilise all descriptions of Wool, from the long silky fleece of the Angora goat to the low common wools of China and India. But yet the manufacturers cannot keep pace with the demand for worsteds and woollens at home and abroad. Other nations also press for supplies of wool, and compete

* Leader in "Mark Lane Express," 1861.

with us in the markets of the world. Already about £10,000,000 a year are required to purchase foreign and colonial wools, and we shall be ready to greatly increase this sum if we can obtain additional supplies at moderate prices; but there has been a gradual upward tendency in prices, owing to increased foreign demands and limited supplies. A leading firm of Liverpool brokers thus speaks of the matter:—"The position of the Woollen and Worsted Trades throughout the manufacturing world is such as to bespeak grave reflections, and ought to command an active sympathy; they are not extending in the same ratio as other branches of industry, and are precluded from doing so for want of adequate supplies of tne raw material. The cry of scarcity which has oeen sounded for the last eight or nine years has produced no practical effect, the small increase of growth having been absorbed without any relief. In England economising expedients have been resorted to on an enlarged scale. The use of cotton in woollen and worsted fabrics has been vastly augmented, and the manufacture of rag wool (which consists of old worn-out woollens torn and ground up) has been developed into quite an important branch of business under the name of 'shoddy' or 'mungo.'" The rag wool is now utilised to the extent of at least 50,000,000 lbs. annually (equal to more than one-third of our yearly importations of colonial and foreign wools) for the purpose of mixing with or adulterating wool in its manufacture, to the great complaint of consumers and buyers of manufactures. This trade, both as regards collection, distribution, and manufacture, is attaining gigantic pro-

portions. Instead of consigning old woollen rags to the soil as manure for hops and other plants, every shred is carefully collected and sorted; and as an article of import, the samples may be seen in city brokers' offices as often, if not to the same extent, as raw wool. So in Leeds, and in other towns of Yorkshire, the business of the rag grinder has become most important, for in Leeds alone there are a dozen or more factories, which produce about 4,000,000 or 5,000,000 lbs. of this rag wool annually. The pieces or patches of cloth are forcibly torn asunder, and remodelled into raw material again, to be once more used by the first customer. The mania for cheap goods has no doubt something to do with this branch of the trade, but deficiency of foreign supply is a main cause. Yet with these enormous aids, the prices of wool, when not checked by adverse extraneous influence, ever gravitate to an extreme range—such, in fact, as effectually to limit the consumption.

Looking to the Continent for any probable additional supplies of wool, we find that Russia, with all her large flocks, can spare us but little, and there is a decrease rather than an increase in our imports from thence. Germany wants all she produces. The imports of wool and woollen yarn in Prussia have been doubling each five years, and the number of sheep decreasing. France is now a large consumer of foreign wools, in addition to her own home supply and the production of Algeria. Four or five years ago her foreign imports of wool were upwards of 83,000,000 lbs., and she supplies woollens to the value of £1,000,000 yearly to Switzerland. The consumption of foreign

wools in Belgium has been largely on the increase. From the Continent we have little, therefore, to expect in the way of increased supplies. Looking back at the last five years, we find that there has been a considerable decrease in our import of German wools, a small increase from Spain and Portugal, a decrease from Iceland and Russia, and stationary supplies from South America generally.

The imports of wool into Liverpool in the last eleven years show a remarkable progression, and yet the supplies are quite insufficient to meet the wants of the manufacturers. In 1850 only 63,774 bales of foreign and colonial wool were received at Liverpool; in 1855 the supply had increased to 113,098 bales, and in 1860 it reached 200,382 bales. This forms a large proportion of the entire imports of the kingdom, which in 1860 were 487,580 bales.

It is true that our aggregate imports of foreign wool have gone on increasing, but so have our exports of wool and woollen manufactures. Last year (1860) our exports of home-grown wool exceeded 11,250,000 lbs., besides the 30,750,000 lbs. of colonial wool re-exported.

Unless we receive additional supplies from India, and our southern colonies, we know not where more wool is to come from. The production of Victoria can scarcely be largely extended at present. Tasmania, New South Wales, and Western Australia will hardly be able to send forward more wool as yet; nor can New Zealand do much, unless with additional labour. Increased supplies might be obtained ere long from the new colony of Queensland, in the north, if

labourers for sheep-tending were available, as there are yet boundless plains of pastoral land unappropriated. In British Kaffraria, and the more northern districts of Southern Africa, there is ample scope for increased wool production, although there are difficulties in bringing it forward for shipment. The wool-production of the Cape Colony has already doubled every five years. From India we have been drawing large supplies of low, coarse wools, and there is an increased field for material of a peculiar class, fitted at least for some purposes. But, as Messrs. Littledale, of Liverpool, well observe: "Our present customers are evidently taking all that we have the raw materials to make; and as the high prices of 1853, 1857, 1859, and 1860 have palpably failed to influence anything like a proportionate increase of supply, the present scarcity must for all practical purposes be considered absolute; *ergo*, all business in woollen and worsted goods to new customers must necessarily be so much abstracted from all the old ones! This is a most unwelcome conclusion to arrive at. To men of the world, having the word 'progression' eternally on their lips, it sounds incredible; but who can gainsay it? Better ask, Where can we look for help? What we want is more wool, for which we can give a good price—50 per cent. above what was considered profitable to grow it ten years ago! We might point to Canada as especially capable of assisting our growth of long wool, to South Africa for an increase of fine colonial, and to India for a larger supply of low wools; but if the stimulus for excessive price has proved insufficient to effect the desired purpose, we are at a loss for a stronger inducement."

The unusually severe weather experienced during the winter and spring of 1860 caused a great falling off in the production of home-grown fleeces, and consequently led to an increased enquiry for all foreign wools that could in any way be adapted as substitutes. As this deficiency is in a very important item of our supply, and is likely to be again experienced this season, it becomes a serious question how the demand is to be met, supposing consumption to progress at the present rate. Messrs. Ronald, the wool-brokers, one of our own correspondents, state: "The position of our market seems at present to be this; there is an increase in the imports of wool, according to the official trade returns, of 10 per cent., from which must be deducted an increase in the export of wool of 9 per cent., thus leaving a surplus of 1 per cent. only. Against this, however, there appears an increase in the exports of manufactured woollen goods and yarns of 8 per cent., which, added to the deficiency in the home-growth of 15 per cent. last year, leaves the supply of wool 22 per cent. short of that of 1859."

There is great room for improvement both in growing and preparing wool for English markets; and some useful hints have lately been thrown out on this subject by brokers. Many countries, particularly North Africa, Turkey, Egypt, Russia, Portugal, and the East Indies, possess breeds of sheep, the wool of which, by the introduction of suitable rams, or by judicious crossing with the best of what they already have, might be vastly improved, and rendered adaptable for many additional purposes. Care should be

taken to eliminate those sheep whose white wool is spoiled by a sprinkling of dark-coloured hairs. The wool should be sent to market more free from burrs, seeds, and filth; and the matted, inferior and coloured fleeces should be packed separately from the good white ones. At the same time an indiscriminate growth of long wool is not at all desirable for the climate and the herbage of some countries, which eminently favour the Merino and Mestizo breeds, but that would prove altogether unsuitable to a larger kind.

COLONIAL WOOLS AT THE LONDON EXHIBITION OF 1862.*

The demand for Wool is increasing very rapidly in all countries; but the production is at present insufficient to meet the demand. The United Kingdom itself produces a larger amount of wool than any other country in the world, but sheep are kept here more for the supply of meat than of wool. The home production of wool is estimated at fully 200,000,000 lbs.; and the imports of all kinds of foreign and colonial wool were in 1860, more than 148,000,000 lbs., of which quantity about 31,000,000 lbs. were re-exported. Notwithstanding our large imports and home production, various expedients and substitutes have been resorted to on an enlarged scale. The use of cotton in woollen and worsted fabrics has been vastly augmented, and the manufacture of rag wool (which consists of old worn-out woollens torn up), has been developed into quite an important branch of business.

* From an Article in the "Scientific Record of the International Exhibition of 1862."

At least 50,000,000 lbs., of this shoddy is worked up annually, and the foreign imports of woollen rags to be torn up and used as a substitute for wool amounted, last year (1861), to more than 17,000,000 lbs.

The British woollen manufacture engages upwards of £33,000,000 of capital, and constitutes a fourth part of our textile manufactures, giving employment to about 900,000 persons. The sources of supply of wool of all kinds to the United Kingdom have been as follows, in bales :—

COUNTRIES.	1850.	1855.	1860.
	Bales.	Bales.	Bales.
Germany	30,491	12,710	14,600
Australia	138,679	163,182	184,000
Cape	19,879	38,272	56,356
Spanish	2,105	213	4,183
Portugal	7,361	4,522	24,503
Peruvian and Alpaca	39,731	42,070	69,075
East India and China	9,701	43,167	62,651
Russian	9,758	1,006	21,445
Mediterranean Ports	13,432	12,066	18,162
Buenos Ayres	3,841	6,338	5,058
Sundries	3,041	5,986	15,650
Goat's Wool	13,139	14,154	11,897
Total bales	291,161	343,686	487,580

Of the whole of the Australian colonies, New South Wales takes the lead in pastoral industry, although Victoria now approaches it closely. When the census returns were taken last year (1861) there were in the colony upwards of 6,000,000 sheep, or at the rate of 1,700 sheep to every hundred of the population. Victoria had at the same time 5,794,000 sheep; Queensland, 3,450,000; South Australia, 2,825,000; Western Australia, 250,000; and Tasmania, 1,701,000.

From New South Wales the flocks and herds of all the other Australian colonies derive their origin. In 1797, Captain John Macarthur, of Camden (a name which must ever occupy the first rank in the annals of Australian progress), being struck with the remarkable effect of the climate of New South Wales on the fleeces of the sheep which had been imported into or bred in the colony, obtained from the Cape of Good Hope three rams and five ewes of pure Spanish merino blood, and crossed all his coarse-woolled ewes with the Spanish rams. This result exceeding his most sanguine expectations, he took an opportunity whilst in this country in 1803, of bringing under the notice of the Government the importance of encouraging the growth of fine wool in the colony, by making grants of unoccupied lands to the flock-masters. The concluding words of his statement laid before Lord Hobart (then Secretary of State for the Colonies) in 1803, are worth recording :—

"Captain Macarthur is so convinced of the practicability of supplying the country with any quantity of fine wool it may require, that he is earnestly solicitous to prosecute this, as it appears to him, important object; and, on his return to New South Wales, to devote his whole attention to accelerate its complete attainment. All the risk attendant on the undertaking he will cheerfully bear; he will require no pecuniary aid; and all the encouragement he humbly solicits is the protection of Government, and permission to occupy a sufficient tract of land to feed his flocks."

In 1796 the number of the sheep in the colony was only 1,531, and from this stock has sprung the vast

flocks which were feeding on the natural grasses of Australia in the close of 1860, numbering in all more than 20,000,000.

The exports of wool from Sydney in 1860, amounted to nearly 13,000,000 lbs., of the estimated value of £1,124,000. Besides this a considerable quantity crossed the Murray river for shipment at Melbourne, or was sent down the Darling for shipment at Adelaide. In the last ten years there have been exported from Sydney not less than 159,000,000 lbs. of wool, of the estimated value of upwards of £11,000,000.

The broadcloths, merinos, shawls, elysians, poplins, and other fabrics from New South Wales show the high character of the wools of this colony.

Passing to another wool-producing colony, Queensland (formerly constituting the northern portion of New South Wales, but in 1861 erected into a separate colony), we find the export of wool from thence in 1860, was upwards of 51,000,000 lbs., valued at an average of 21¼*d.* per lb., and the number of sheep is close on 3,500,000.

Although there is a present demand for clothing wool, the Australian sheep farmers would be very wrong to direct their attention to the production of coarse wool, instead of the finer wool for which the climate is so especially adapted. The farmers of Germany, who labour under disadvantages, and who, in many cases, have to protect their sheep from the inclemency of the weather, might, on the contrary, produce clothing wool on a more extensive scale to the advantage of their population, who would gain in

food by the larger carcass; while the Australian colonists might be left to supply the fine wools required for broadcloths, and for which their climate and pastures are so well suited.

Victoria makes a great display in this, one of its most important staple products, in a couple of trophies in the front and rear of their court, built up entirely of bales and samples of Port Phillip wool.

Victoria has always been celebrated as a pastoral country from the first date, when (about a quarter of a century ago), the early settlers from Van Diemen's Land landed with their flocks and herds at Port Phillip to seek new pasturage. Since that period the colony has furnished upwards of 300,000,000 lbs. of wool to the markets of Europe, worth more than £20,000,000 sterling. Notwithstanding the counter attractions of the gold fields, the clip of wool has not declined, but sheep farming is pursued as steadily and profitably as ever. The shipments of wool from the colony in 1860 exceeded 24,250,000 lbs., and the number of sheep owned there is about 6,000,000.

Among the choice wools exhibited are portions of sixteen bales sent by Messrs. Clough and Co., and wool with the mark "J. B." in a circle, the growth of Mr. J. Bon, Devil's River, who has 15,000 sheep. The other chief exhibitors are Mr. W. Skene, who owns 25,000 sheep; the estate of Benn Bank, 30,000; Ardachy, 20,000; Waurrough, 20,000; Gray, 25,000; and Winter Brothers, 50,000.

Eight glazed cases of Victoria wools are deserving of special notice, as each contains twelve fleeces of the following characters of wool with their specified weight :—

1. Greasy merino, grown by J. S. Currie, Lasee-Cressy, of first-class quality.

	lbs.	ozs.
3 Ewes	22	6½
3 Wethers	29	13½
3 Hoggetts	22	13
3 Lambs	14	11

2. Washed merinos, by the same grower.

	lbs.	ozs.
3 Ewes	11	7
3 Wethers	17	15
3 Hoggetts	12	5
3 Lambs	7	1½

3. Washed merinos by T. McKellar, Kanawaila, Hamilton.

	lbs.	ozs.
3 Ewes	9	13½
3 Wethers	11	12½
3 Hoggetts	12	15
3 Lambs	8	8

4. Washed wool, by G. A. Browne, Mount Emeu. This farm contains 25,000 sheep.

	lbs.	ozs.
3 Ewes	13	10
3 Wethers	16	12
3 Hoggetts	13	8
3 Lambs	6	13

5. Sundry prize samples of wool, exhibited by J. H. Clough and Company, wool brokers, Melbourne.

	lbs.	ozs.
3 Fleeces each of Negretti	14	5
3 " "	12	14½
1 Hoggett Fleece	3	5
1 Ewe and 1 Lamb Fleece, each	2	6½

6. Twelve fleeces of greasy wool, grown by T. and S. Learmouth, Ercildoun, Borumbeet, which obtained the highest reward for merit at the local Exhibition in the colony—a double first-class certificate :—

	lbs.	ozs.
3 Ewes	20	3
3 Wethers	23	13
3 Hoggetts	22	8
3 Lambs	11	10

7. Twelve fleeces of washed wool, by the same grower.

	lbs.	ozs.
3 Ewes	12	7½
3 Wethers	14	7½
3 Hoggetts	13	0½
3 Lambs	5	14½

8. Twelve fleeces of merino in the grease, grown by Mr. Wilson, Rokewood, weighing respectively.

	lbs.	ozs.
3 Ewes	23	7
3 Wethers	25	11
3 Hoggetts	17½	0
3 Lambs	10	0

Tasmania sends but a small quantity of wool.

There is a very fine washed fleece, an average of 100 bales, from the estate of Lord Talbot de Malahide, and a fine specimen of lamb's wool, with the mark of the Isle of Man arms.

Western Australia has only forwarded two or three samples. The commencement of sheep-keeping in this colony on any scale dates from the opening of the York district in 1822, when Messrs. Bland and Truman drove a flock to the district consisting chiefly

of merinos. These, however, degenerated, and meat being an object, were thought too small. Cotswold rams and Southdown ewes were subsequently introduced, and found suited to the wants of the colony, as they combined pureness of quality with length of staple and large carcass. Additions have also been made of rams of the Romney Marsh breed.

New Zealand, which is a rising wool-producing colony, sends samples of various mixed-breed wools, crosses between the Merino, Cotswold, and Leicester. Wellington, Nelson, and Auckland, each contribute wool; but Canterbury and the other provinces do not seem to exhibit.

As the Cape Colony is unrepresented on the present occasion, Natal wools are the only samples of South African produce, and they are by no means of a good quality, having received but little care. The sheep thrives in many parts of the Natal uplands, and in the Free States beyond, and is now gradually introduced into the lower region around the capital with varying degrees of success. Gentlemen who have had large experience in the management of sheep in other lands are turning their attention to its care, in the conviction that where proper attention and skill are devoted to the object, where the sheep are hurdled and fed on the hill tops, and kept clear from scab, which has hitherto been entirely disregarded in the colony, mutton and wool will be remunerative, even in those lower localities. In the year 1861 about 650,000 lbs. of sheep's wool, worth £33,000, were exported from Natal, much of it, of course, being the produce of the Overberg States. There are only

about six samples of colonial-raised wool shown, and these compare, of course, unfavourably with the finer wools of New South Wales, Queensland, and Victoria in the adjoining courts.

There are many samples of Indian wool shown in the East India Government collection in the north-east gallery. The imports of Indian wool have largely increased of late years, averaging in the past two years 20,000,000 lbs., or more than the receipts from South Africa. Although most of the wool received from India is of a very coarse and kempy character, it comes into use for common purposes.

OUR WOOLLEN MANUFACTURES.*

The second great textile industry of the kingdom, that of Wool, although of late years outstripped by Cotton, was in earlier days our most important manufacture. There are more than 250,000 operatives engaged in the factories, while the total number of persons directly dependent upon the trade may be set down at fully 1,000,000 (including the operatives), there being a larger number of dependent workers in its auxiliary trades than in connection with any other manufacture.

If we look minutely at the export trade of British wool and woollens, we find it now constitutes one-sixth of the total value of our exports, cotton forming one-fourth and iron one-sixth.

	Value of Woollen Manufactures and Yarns Exported.	British Wool.
1850	£10,040,332	—
1855	9,744,469	£986,523

* Published in "Kelly's Post Office Guide to London, 1871."

	Value of Woollen Manufactures and Yarns Exported.	British Wool.
1860	16,000,448	877,082
1865	25,534,234	901,660
1870	26,659,202	580,570

The value of the foreign and colonial wool imported averages more than £16,000,000 sterling, and of foreign woollen manufactures we import to the value of £3,000,000 to £5,000,000 annually.

The Statistics of the Woollen Industry of the United Kingdom were thus given in the Census returns of 1861:

Division and Counties.	Woollen Factories.	Spindles.	Power Looms.
ENGLAND AND WALES:—			
Yorkshire	924	1,296,190	11,405
Devonshire	16	12,585	255
Gloucestershire	49	59,986	618
Lancashire	101	277,655	6,377
Montgomery	43	20,920	262
Somersetshire	26	31,401	401
Wiltshire	32	44,825	549
Other Counties	265	103,288	477
Total	1,456	1,846,850	20,344
SCOTLAND:—			
Aberdeen	25	17,510	93
Clackmannan	15	38,311	214
Peebles	7	51,142	101
Perth	16	16,353	—
Roxburgh	21	60,747	300
Selkirk	16	46,368	158
Stirling	23	32,950	64
Other Counties	61	53,804	373
Total	184	317,185	1,303
IRELAND	39	18,574	123
Total United Kingdom	1,679	2,182,609	21,770

The great progress made in the manufacture of late years is shown by the following official figures (the latest available), and the increase of factories and machinery indicates the activity of the trade.

1868.

WOOLLEN, WORSTED AND SHODDY FACTORIES.

Division.	Factories.	Spindles.	Power Looms.
England and Wales..	2,211	6,512,590	118,755
Scotland	207	436,134	3,529
Ireland	47	28,104	215
Total	2,465	6,976,828	122,499

OPERATIVES EMPLOYED.

England and Wales................................	233,535
Scotland..	18,174
Ireland	1,378
Total....................	253,087

The Cotton factories (2,549) in the United Kingdom employed in the same year 401,064 operatives. The total number of persons employed in the woollen and worsted factories in England and Wales in 1868 was in

WOOLLEN FACTORIES.

Spinning..	16,510	
Weaving..	2,284	
Spinning and Weaving	75,659	
Finishing	5,160	
Other descriptions of Work	2,325	
		101,938
Shoddy Factories....................................		3,187
Carried forward		105,125

Brought forward		105,125
Worsted Factories.		
Spinning	42,983	
Weaving	17,601	
Spinning and Weaving	66,689	
Other descriptions of Work	1,137	
		128,410
Total		233,535

An estimate of the woollen and worsted trade of the United Kingdom was furnished to the Rivers Commission in the course of their inspection of the West Riding of Yorkshire for the year 1864. From these returns the wool produced in the United Kingdom in that year was stated at 152,000,000 lbs., of which more than 7,000,000 lbs. were exported, leaving nearly 145,000,000 for home consumption. It was estimated that in the year 1864, in this kingdom, the produce and imports of wool and similar material amounted to 447,445,889 lbs.; and 63,254,102 lbs. of wool being re-exported, there remained 384,191,787 lbs., of the value of £31,698,120. This vast amount of raw material was worked up thus:—35,500,000 lbs. of English wool exported as yarn, of the value of £5,000,000, and the following quantities manufactured into tissues of the values undermentioned, namely:—110,000,000 lbs. of English wool into tissues of the value of £22,000,000; 150,500,000 lbs. of foreign wool into tissues of the value of £22,600,000; 4,900,000 lbs. mohair into £1,200,000; 4,500,000 lbs. of foreign yarn into £1,800,000, and 79,500,000 lbs. of shoddy and extracts contributed to the extent of £4,000,000 to the value of the tissues; the whole producing worsted and woollen yarns and tissues of the

value of £57,100,000. To this has to be added cotton yarn and other materials for mixing, not above enumerated—£7,300,000—bringing the whole value of the products to £64,400,000. Another analysis gave the following estimate;—140,500,000 lbs. worked up into worsted and woollen goods exported, or exported as yarn, together of the value of £23,948,800; and the other 243,700,000 lbs. were worked up into worsted and woollen goods for home consumption, of the value of £40,451,200.

According to the latest official return, the woollen and worsted trades of the kingdom gave direct employment respectively to the following:—

	Factories.	Operatives.
Woollen	1,658	118,004
Shoddy	104	3,187
Worsted	703	131,896
Total	2,465	253,087

In a paper read by Mr. Archibald Hamilton before the Statistical Society of London, in December, 1870, on "Our Wool Supply," he stated that—

"The importations of wool during the last fifty years have increased with such marvellous rapidity, that this material now ranks second in importance as regards our textile industry; and has this peculiarity, that, whereas cotton and silk are produced only in certain latitudes and in comparatively few countries, wool is produced, more or less, in all countries. Another characteristic is the great variety of qualities, comparing the produce of one country with another, or even of different districts in the same country—

each fleece, indeed, contains several 'sorts' adapted for various purposes—so that there is, perhaps, no single article of commerce that gives rise to so many dealings as wool: interchange of their produce takes place even between manufacturing countries; for example, we import from Germany 7,000,000 lbs. annually, and the German manufacturers take 2,500,000 lbs. of English wool, in addition to yarn spun from the same material.

"Again, wool is so much preferred to any other material for nearly all clothing purposes, that the use of woollen and worsted goods has hitherto been restricted only by the cost—the consumption extending readily as the price of wool becomes less—and notwithstanding the extraordinary increase in the imports, there has been as yet no accumulation of wool in stock, if we except the present year, when the natural course of things has been interrupted by the war."

London is largely interested in the woollen manufacture, as the bulk of the foreign wool imported comes to London. Out of 880,000 bales received in 1870, 711,000 came to London, and were distributed to the home and foreign manufacturers at the colonial wool sales held in London. Liverpool received about 148,000 bales. There are in London 5 wool warehouse-keepers, 33 wool-brokers, 29 wool-merchants, and 18 woolstaplers, to say nothing of the 163 woollen warehousemen, and the large array of woollendrapers who supply the customers of the metropolis.

We are mainly dependent on our southern colonies in Australia and Africa for our supplies of wool.

Germany furnishes small quantities of the finer kinds, and the River Plate districts are increasing their exports, although the quality is not so good as the Australian. The rapid progress in the woollen trade is best illustrated by the increasing supplies of foreign and colonial wool of all kinds used up as shown in the following quinquennial figures, in lbs.:—

Countries.	1855.	1860.	1865.	1870.
BRITISH POSSESSIONS.				
Australasia	49,142,000	59,166,000	109,734,000	175,081,427
India...................	14,283,000	20,214,000	17,105,000	11,143,148
South Africa	11,075,000	16,574,000	29,220,000	32,785,271
FOREIGN COUNTRIES.				
Spain	68,000	1,000,000	115,000	23,686,039
Germany	6,128,000	9,292,000	6,858,000	
Other European States .	8,119,000	28,570,000	27,693,000	
South America	7,106,000	8,950,000	17,867,000	16,666,078
Other Countries........	3,379,000	4,630,000	3,614,000	
Total Imports	99,300,000	148,396,000	212,206,000	259,361,963
Re-exported	29,453,000	30,761,000	82,445,000	92,542,384
Left for consumption ..	69,847,000	117,635,000	129,761,000	166,819,579

The computed nett value of the sheep's wool, and woollen rags (torn up to be used as wool) in 1871 was nearly £18,000,000, and of foreign woollen manufactures and yarns imported upwards of £5,500,000, making a total of about £23,500,000 paid for foreign and colonial woollen raw material and manufactures.

	lbs.
Our home supply of British grown wool has been carefully estimated at.........	160,000,000
Our imports, Foreign and Colonial, of sheep's wool in 1871 were	319,511,000
The skin wool from imported sheep is estimated at	2,400,000
Making a total of...........	481,911,000

Total, brought forward		481,911,000
Foreign and Colonial re-exported	92,542,000 lbs.	
Domestic wool exported	12,400,000	
		104,942,000
Leaving for home consumption		320,709,000

Besides some 40,000,000 lbs. of shoddy, or rag wool, made at home, and 51,500,000 lbs. imported.

The gross value of worsted and woollen yarn and British-made goods exported in 1870 was made up of the following items:—

Worsted Stuffs	£13,788,798
Hosiery, &c.	265,856
Small Wares	388,872
Carpets	1,393,279
Flannels and Blankets........................	1,078,983
Woollen Cloth, &c............................	4,749,165
Woollen and Worsted Yarn	4,994,249
	£26,659,202
British Raw Wool............................	580,570
	£27,239,772

These details will serve in some degree to point out the real magnitude and value of the woollen manufacture which have hitherto been most imperfectly known.

We know the quantity and value of the manufactured goods exported, but we have no guide to the precise amount consumed by our own large and well-conditioned population in these islands; this some of our most experienced merchants estimate to be three-fourths of the whole manufacture. If we allowed but

£1 a year for woollen goods for every head of the population, this would give us fully half the manufacture, which cannot certainly be set down in value of annual production at less than £70,000,000.

Why are all manufactured goods more abundant, relatively to the population, now than in 1700? First, because every man now works with better tools, and more manual skill and dexterity; because all modes of transit have been improved, thus facilitating the transmission of goods, either raw material or finished, and thereby reducing one great element of the price, the cost of carriage; and because, further, the facility of transport has rendered exchange practicable and easy, when formerly it was impossible; thus actually creating new industries. And to whom or to what do we owe the more perfect appliances of the present day? Unquestionably and primarily to such men as Watt and Arkwright, Crompton and Hargreaves, Kaye and Cartwright, in the department of mere mechanical appliances—the steam engine, the carder, the mule, and the power-loom being the great types of this department; and subsequently to our Brindleys and Stephensons, our Sharps and Fairbairns in the department of transit—the canal, the railroad, and its great king the locomotive engine, the steamboat, the railway tunnel, and the viaduct being its chief types. Nor should injustice be done to a thousand other names in every department of productive art, whom it would fill a volume merely to enumerate.

What, then, has progress in the woollen and worsted trades done for the land of Great Britain? It has—speaking generally—doubled its production

of wool in proportion to population, and probably quadrupled the proportion of sheep since 1700, for the sheep of the present day is a very different animal in weight and value to that of the seventeenth century. It has quintupled the rental of England, although much of the land has been monopolised for railways, mines, quarries, towns, mills, &c. Within the last century and a half implements which retained the closest resemblance to those used by the earliest nations of the world—the people of Central and Western Asia—have been displaced by the prodigious power of steam, the mule and spindle, and the power-loom. The progress of this industry has given activity and occupation to thousands in Australia, in South Africa, and South America. It has freighted tons of shipping annually, and fostered Commerce, and yet population during the displacement has gone on with a geometric ratio of increase, and there appears no limit to the progress either of the population or of manufacturing art, but the limit of the earth's surface to supply food.

The proportion of the fleece of one sheep per head to the population kept in the kingdom, does not furnish enough wool for our own use, irrespective of the export demands made for our woollen manufactures; hence our factories are such excellent customers to the sheep breeders of the Cape, Australia, and the River Plate.

The woollen manufacture begins with the stapler, who buys the wool of the farmer or broker, and ends with the merchant. It is divided into three principal processes, which are again subdivided.

First, there is what is called the manufacturer; secondly, the finisher; and thirdly, the rag grinder. The first manufactures the raw material into cloth; the second finishes it, or gives it its appearance as it is ordinarily worn; the third takes the manufacture of the two former processes when thrown aside by the wearer, cuts it into pieces, which he forcibly tears asunder, and then remodels them into raw material again, to be once more used by the first customer.

Of so much consequence is this last process to the trade, that the rag machines of the town of Leeds alone are capable, in full work, of adding to the annual stock of wool the equivalent of the fleeces of 600,000 sheep, averaging 7 lbs. each.

From a parliamentary return issued in 1868, the number of woollen factories was 1,658, with 1,109 combing machines, nearly 4,200,000 spinning spindles, 167,248 doubling spindles, 46,294 power looms, 33,270 power-loom weavers, about 1,100,000 billy spindles, 1,370 condensers, 2,670 gigs, and 3,879 fulling stocks. The moving power was 38,800 steam, and 10,624 water power. The total number of persons employed in the woollen factories was 118,904, of whom 59,771 were males, and 58,233 females.

The woollen trade of the kingdom is divided into three great sections, comprising—A. What is known as worsted fabrics made from combed wool. B. Woollen fabrics made from carded wool. And C. Shoddy fabrics, made chiefly from old woollen rags, the wool extracted from mixed fabrics, and re-worked up with a little new.

A.—THE WORSTED MANUFACTURE.

THE worsted manufacture, though for some centuries it had its chief seat in Norfolk, Suffolk, and Essex, has now obtained a remarkable concentration in the West Riding of Yorkshire. Out of 131,896 factory operatives in the worsted trade of the United Kingdom, 121,978 are in Yorkshire.

The town of Bradford is the principal centre of the worsted manufacture, and the great market for the disposal of its productions. There are also large numbers engaged at Halifax, Keighley, Bingley, and Wakefield, besides others, distributed over adjacent villages and other counties, such as Leicester and Norfolk. To these must be added a large number of persons employed in Lancashire in the manufacture of mousseline-de-laines and other light worsted fabrics, and who in the Factory Returns are included in the department of cotton. It should also be borne in mind that besides the hands employed within the factories there are numbers of wool-sorters, combers, hand-loom weavers, dyers, &c., employed out of the factory, and these, at a moderate calculation, may be reckoned at fifty per cent., or one workman employed out for two in.

The worsted factories in 1868 were 687, of which 293 were employed in spinning, 2 being in Devon, 1 in Durham, 3 in Lancaster, 4 in Norfolk, 2 each in Somerset and Westmoreland, 7 in Worcester, and 272 in York; 213 exclusively employed in weaving, of which 1 in Durham, 5 in Lancaster, 3 in Warwick, 24 in Worcester, and 180 in York, besides which there

were 165 employed both in spinning and weaving, all in Yorkshire, except 1 at Worcester. There were besides these, 16 factories not included in the above descriptions, 1 being in Durham, 2 in Lancashire, 3 in Middlesex, and 10 in Yorkshire.

A distinguishing feature in the worsted trade is the variety of fabrics produced, and the diversity of purposes to which they can be applied. Thus, we have fabrics composed entirely of wool, of wool and cotton, of wool and silk, of wool, silk, and cotton, and of alpaca and mohair mixed with cotton and silk. The first division includes the old fabrics called says, serges, shalloons, lastings, and other stout and heavy articles largely consumed in the export trade. It also includes damasks for furniture and hangings, made chiefly at Halifax, and single-twilled merinos, which, up to the year 1836, was the main article sold for ladies' dresses. Under the second head are comprised the two fabrics known as Cobourg and Orleans cloths, the production of which is immense. The silk warp and worsted weft goods are rich and durable, and include the elegant productions of the Norwich looms. The alpaca and mohair manufactures are carried on chiefly at Bradford and Bingley, and are used largely for ladies' and children's dresses, for coatings, vestings, linings, umbrella and parasol cloths, &c.

In 1787 the average rate of wages paid in the worsted trade in fifteen counties was 3*s*. 3*d*. per week. A little later 5*s*. a week for a weaver was accounted a great payment; and this be it remembered, when a stone of flour weighing 16 lbs. cost the working man from 3*s*. to 3*s*. 6*d*. At the present time,

with flour at 2*s.* to 2*s.* 6*d.* per stone—with other articles of provision reduced in proportion, with articles of clothing one-third at least of their former price—the average wages at Bradford of all factory workers, men, women, and children, is 10*s.* to 12*s.* a week; nor is the amelioration in their social condition less real.

After deducting the export of worsted goods, there will still remain for the whole female population of Great Britain and Ireland, from the infant in the nurse's arms to the "oldest female inhabitant," a dress of worsted stuff each year seven yards in length.

In Bradford and its neighbourhood the rate of wages paid to persons employed in the worsted manufactures is as follows:—

Wool sorters 28*s.* per week to men and 12*s.* to lads and boys; to wool washers, men, 17*s.* 6*d.*; dyers, men, 20*s.*, boys, 8*s.* to 12*s.*; machine wool-combers, men 15*s.*, lads, 8*s.* 6*d.*, women, 9*s.* 6*d.*; drawers, reelers, and weavers, women, 10*s.* to 12*s.*; overlookers, 30*s.*; assistant overlookers, 10s. to 28*s.*; engine tenters, 28*s.* to 35*s.*; engine feeders and stokers, 20*s.*

In Halifax and its neighbourhood the weekly wages are:—Wool sorters, men, 18*s.* 6*d.* to 28*s.*, boys, 12*s.*; wool washers, men, 12*s.* to 22*s.*; wool carders, women, 9*s.* to 9*s.* 6*d.*; machine wool-combers, men, 12*s.* to 15*s.*, women, 9*s.* to 9*s.* 6*d.*, girls, 9*s.* to 9*s.* 6*d.*; makers-up, boys and women, 9*s.* to 10*s.*; dyers, men, 14*s.*; drawers, women and girls, 8*s.* to 10*s.*; spinners, women (full time), 6*s.* 6*d.* to 8*s.*, boys and girls (short time), 1*s.* 3*d.* to 4*s.*; twisters, girls, 8*s.* to 10*s.*; reelers, women and girls, 9*s.* to 14*s.*; oilers, boys, 9*s.*;

jobbers, boys, 8*s.* to 10*s.*; bobbin setters, boys, 5*s.*; doffers, boys, 6*s.* 3*d.*; weavers (piece work), girls and women, 14*s.* to 18*s.*; overlookers, 18*s.* to 25*s.*; assistant overlookers, 13*s.* 6*d.* to 16*s.*; engine tenters, 22*s.* to 30*s.*; feeders and stokers, 14*s.* to 18*s.*

B.—THE WOOLLEN MANUFACTURE.

The West Riding of Yorkshire and the West of England are the chief seats of this extensive industry. Leeds is the most important centre, and may be considered the metropolis of the woollen trade. Huddersfield, with its neighbourhood, is the second in importance, and is famed, in addition to the production of broad cloths, for its large trade in fancy trouserings. In the West of England, Trowbridge, in Wiltshire, is the centre of a large district which produces fancy goods and light cloths of many descriptions; and Stroud, in Gloucestershire, is celebrated for its scarlet and other bright-coloured cloths, a celebrity which it derives from the peculiar fitness of its waters for the dyeing processes.

The woollen manufacture, with its various branches, is very extensively diffused, and not concentrated like cotton. According to the last factory returns, it prevailed in 23 counties of England, 10 of Wales, 25 of Scotland, and 12 of Ireland.

More than one-half of the operatives employed in the woollen factories were in the county of York—57,843 out of 101,938.

The Scotch goods, tweeds, tartans, &c., are generally of a beautiful soft character and permanent dye.

Blankets, which are also included in this class, are made chiefly at Witney, in Oxfordshire, and at Dewsbury, in Yorkshire.

Flannels are produced in Wales chiefly by hand labour, and Rochdale and district is now the centre of the English branch of this trade. Felt druggeting is made in the Yorkshire districts, and is largely used in England as a cheap substitute for carpets.

The woollen factories employed in spinning, in 1868, were 549, distributed as follows :—Anglesea, 13 ; Brecon, 9 ; Cardigan, 30 ; Carmarthen, 22 ; Carnarvon, 21 ; Chester, 5 ; Cornwall, 1 ; Cumberland, 8 ; Denbigh, 11 ; Derby, 4 ; Devon, 3 ; Durham, 1 ; Flint, 2 ; Glamorgan, 35 ; Lancaster, 8 ; Leicester, 22 ; Lincoln, 1 ; Monmouth, 16 ; Montgomery, 23 ; Norfolk, 2 ; Nottingham, 2 ; Oxford, 8 ; Pembroke, 18 ; Salop, 4 ; Somerset, 8 ; Westmoreland, 9 ; and York, 263.

There were 42 employed specially in weaving, located in the following counties :—Chester, 2 ; Lancaster, 2 ; Pembroke, Salop, and Somerset, each 1 ; and York, 35.

The number employed in spinning and weaving, conjointly, was 635, located as follows :—Carmarthen, 2 ; Carnarvon, 1 ; Chester, 10 ; Cornwall, 1 ; Cumberland, 2 ; Denbigh, 5 ; Derby, 9 ; Devon, 9 ; Durham, 3 ; Gloucester, 62 ; Hereford, 2 ; Lancaster, 81 ; Monmouth, 5 ; Montgomery, 9 ; Northumberland, 9 ; Oxford, 2 ; Pembroke, 1 ; Radnor, 1 ; Somerset, 11 ; Westmoreland, 3 ; Wilts, 25 ; and York, 382. Of factories employed only in finishing, there were 34 in Lancashire and 96 in York ; and besides these were

64 factories not included in either of the above descriptions, situated—5 each in Chester and Devon, 1 each in Leicester, Middlesex, and Northumberland, 9 in Somerset, and 42 in York.

C.—SHODDY FABRICS.

The number of shoddy factories, in 1868, was 23 in Lancashire and 81 in Yorkshire. These gave employment to 3,187 persons, about half males and half females. Old or second-hand materials are extensively used in the manufacture of the lower classes of woollen goods; these are shoddy, mungo, and extract wool. At one time the name of shoddy was sufficient to excite prejudice, if not disgust; but that time has passed away, and the useful properties of shoddy, when judiciously applied, have long since been recognised, for at present the industry of whole districts depends upon it; its value and importance in a commercial point of view being second only to that of wool. The annual production and consumption of rag wool, or shoddy, is now equal to one-sixth of the amount of our foreign supplies of wool.

Shoddy is of three kinds:—1. Shoddy, manufactured from soft woollen rags—as flannels, blankets, stockings, carpets, &c. 2. Mungo, manufactured from hard and fine woollen rags, and new cloth cuttings, &c. 3. Extract wool; that is wool extracted from mixed cotton and woollen rags by a chemical process, which consumes the cotton, leaving the wool intact. The two former sorts are held in the greatest estimation as possessing better felting properties.

Batley is the chief seat of the manufacture of shoddy. This is the famous rag capital, the tatter metropolis whither every beggar in Europe sends his cast-off gentility of moth-eaten coats, frowzy jackets, worn-out linen, offensive cotton and old worsted stockings; this is their last destination. Reduced to filament and greasy pulp by mighty "swifts" or revolving toothed cylinders, the much vexed fabrics re-enter life in the most brilliant forms—from solid pilot cloth to silky mohair and glossiest tweed. Thus the tail coat rejected by the Irish peasant, the gabardine too foul for the Polish beggar, are turned again to shiny uses, reappearing, it may be, in the lustrous paletôt of the sporting dandy, the delicate riding habit of the Belgravian belle, or the sad, sleek garment of her confessor. It is an ascertained fact that rag machines were in use in London prior to their being so in Yorkshire, and that they were employed in making flocks from rags for saddlery and upholstery purposes.

In addition to the quantity of home-made rag wool, there is a large importation of foreign constantly going on, the average imports of the three years ending with 1871 being 19,000 tons a-year. More than 100 firms and individual tradesmen in Yorkshire are engaged in the preparation and sale of rags, shoddy, and mungo. Exclusive of the people employed at the rag grinding and shoddy factories, there are probably 500 female rag sorters or pickers.

In the woollen manufacture a considerable portion of the raw material is scattered as waste; but there are a number of "waste merchants" in different parts

of the country who buy up everything like wool, and send it to Leeds, Dewsbury, and Batley to be made into shoddy or mungo. Being mixed with some new wool it is spun into yarn, and made into broadcloth, doeskins, pilot cloths, druggets, and coarse carpetings. The reproduction of a woven fabric from material formerly regarded as entirely waste and useless for such purposes, is a striking illustration of the adaptive ingenuity of the present day.

Besides the woollen rags collected at home, others are imported. These are all torn up by machinery, and their fibrous material entirely separated; it is then spun into "low numbers" and made into a coarse description of woollen cloth, used for baize, table covers, &c.

EXPORTS OF BRITISH WOOLLEN MANUFACTURES.

Year.	Flannels.	Blankets.	Carpets and Druggets.	Shawls and Rugs.	Worsted Stuffs.
	£	£	£	£	£
1862	...	...	671,215	...	5,881,789
1863	...	...	810,783	...	8,336,957
1864	...	...	861,499	...	10,800,521
1865	...	...	861,453	...	13,360,527
1866	...	...	1,217,682	...	13,294,059
1867	415,881	361,775	1,101,986	287,208	12,144,998
1868	431,845	452,902	1,099,882	264,555	13,075,773
1869	404,890	694,409	1,466,758	265,918	15,130,340
1870	343,641	713,342	1,393,279	267,772	13,788,798
1871	397,187	631,751	1,650,773	...	17,953,992

HOSIERY, STOCKINGS, AND OTHER SMALL WARES.

1867	£390,609
1868	371,036
1869	696,978
1870	654,728
1871	982,383

EXPORTS OF WOOLLEN AND WORSTED YARN AND MANUFACTURES.

Yarn. Years.	£	Woollen Manufactures. Years.	£
1862	3,852,998	1862	4,425,122
1863	5,087,293	1863	3,964,910
1864	5,417,377	1864	4,533,519
1865	5,429,504	1865	4,023,954
1866	4,742,162	1866	5,303,602
1867	5,822,996	1867	5,327,375
1868	6,364,011	1868	3,760,961
1869	5,538,295	1869	4,275,858
1870	4,994,249	1870	4,749,165
1871	6,101,777	1871	5,568,618

One-third of the manufactures exported is mixed goods, and the remainder all woollen.

THE SILK TRADE AND MANUFACTURE.*

Some idea may be formed of the importance of the Silk Trade of the United Kingdom from the fact that our average annual import of raw silk in the eight years ending with 1859, was nearly 1,500,000 lbs. exclusive of more than 3,500,000 lbs. of waste silk and knubs or husks. In 1860 and 1861 the import averaged 9,000,000 lbs. of raw and thrown, and last year (1861) 290,627 cwts. of waste was received. The sources of supply have much changed of late years. Italy and Syria now furnish us with very little, the supplies from France fluctuate, and we are chiefly dependent on the coarse silks of the East. There are nearly 500 silk factories in Great Britain, in which 5,176 horse power is engaged, and a capital of about £50,000,000 sterling embarked, which gives employment to nearly 1,000,000 persons.† In the

* From an Article in "The Scientific Reoord of the International Exhibition of 1862."

† Progress of the Silk Trade of the United Kingdom' from 1845 to 1870.

	1845. Quantities.	1850. Quantities.	1855. Computed Value.	1870. Computed Value.
Imports of European silks, exclusive of lace, mittens, and ribbons .... lbs.	341,441	698,716	£ 509,183	£ 15,096,327
India silks ....pieces	782,782	766,941	313,285	146,592
Raw silk .... lbs.	4,354,696	4,942,407	4,584,733	8,696,598
Thrown silk .... „	511,832	469,527	908,571	599,651
British silk manufactures exported, including thrown and twist, declared value £	766,405	1,255,641	1,524,343	1,450,397

Eastern Annexe, we have one exhibitor of British raw silk, in G. Mason, of Yateley, Hants, who shows fine cocoons, hanks of raw silk, and fabrics made of it, and the waste for spinning. Lady Dorothy Nevill, of Dangstein Park, Petersfield, has lately been giving great attention to the introduction of the *Alianthus* silkworm (*Attacus Cynthia*) into this country, and has translated and published here the treatise of M. Guèrin de Meneville on the subject.

The production of silk is an important branch of industry open for future skill and exertions in many of our colonies. In Victoria copious plantations, recently formed, of the quickly-growing Chinese mulberry tree, testify that many of the colonists are persuaded of the great importance of encouraging this branch of rural economy. Queensland, New South Wales, South Australia, Mauritius, and Natal contribute small samples of silk, evidencing what might be done by pains and attention at some future day.

Silk culture in Austria is confined to the Southern and Adriatic provinces of the empire, having reached its highest development in the Venetian Provinces and Southern Tyrol. Trials made in the other provinces have not as yet been attended with much result. The annual average production of cocoons amounts to from 270,000 to 300,000 cwts., of which in 1860 there were sent to other countries 6,000 cwts.

The number of persons permanently employed in the silk industry, and temporarily for a month or two after the collection of the cocoons, is about 100,000. The collective exhibition of the Vienna silk manufacturers is a very interesting study. 83 spinning establish-

ments with nearly 4,000 boilers, steam power for heating and mechanical motion, are at work in Austria.

Italy has long been famous for its silks, and although the silk growers and manufacturers do not make so good a display here as was done on their own soil, in the Florentine Exhibition in 1861, yet the practised eye cannot but be struck by the splendid specimens shown in the Italian Court by 133 exhibitors. The annual productions of the silkworm in Italy were recently estimated by Mr. T. Winkworth at upwards of £12,000,000 sterling: 4,232 tons of raw silk are produced; and there are 984 tons of refuse silk after reeling worked up; 1,970 tons of native silk are thrown into organzine and tram, and half as much Chinese and Italian silk.

The number of exhibitors of silk from France is very large, and includes individual and collective exhibitors, as well as those of many societies. There are also many exhibitors from the French colonies, whom it would be impossible to enumerate in detail. There are fine yellow cocoons and silks from Cochin China, shown by Vice-Admiral Charnier. The Horticultural and Acclimatisation Society of Montauban exhibits 16 varieties of improved cocoons with the raw silk. M. Tessier du Cros has an interesting collection of cocoons comprising the following varieties:—yellow, from Smyrna; white, Adrianople; white, Lefhra, Anatolia; saffron, Archipelago; white, Mehemet Effendi; green, Archipelago; yellow, of France (old Melanie breed)—white (old breed); white, Montauban; white, Cahors; white, Adrianople; yellow, Valuchon. This exhibitor has carried off nine medals

from the Society for the Encouragement of National Industry.

In the collection of the Imperial Acclimatisation Society of Paris, there was shown a very interesting collection of silk moths, cocoons, and their products, comprising 11 species—namely, the silk moth of the Japan mulberry, of the castor-oil plant of India, (*Bombyx arrindia*), of the Ailanto of China (*Attacus Cynthia*), the wild silk moths of the oaks of China, of India, and of Japan (*Antheræa Pernyii, A. mylitta, and A. yama-maï*); *A. cecropia* of North America; *A. aurota* and *A. speculum* of Central America, and *Attacus Atlas* and *Actias Selene* of India.

From Pondicherry M. Perottet sends raw and waste silk and cocoons of the larva of the handsome *Bombyx mylitta*. For several years past he has transmitted living cocoons of this moth to France, and the worms have fed well on the oak leaves of the forests. He also exhibits fine cocoons of another *Bombyx* of great beauty, the name of which is not known; the worm feeds on the leaves of the *Rhus Odina*. Raw white silk is also shown, obtained from the eighth generation of the worm of the *Bombyx mori* at the experimental establishment of Pondicherry in 1859. The silk, which is spun from 5 to 6 cocoons, is about 11½ to 12 deniers fineness, and sells at Lyons at from 75 to 95 francs the kilogramme.

Bengal silk is not much esteemed in this country. For some years foreigners were the largest consumers of the better classes, but now they seem to have enough of their own silks, aided perhaps by Japan silk, for their restricted consumption; and the lower class

qualities have been effectually kept out of consumption by the abundance and moderate prices of the common classes of China and Japan silk.

In 1850 we received 346,847 lbs. of Indian silk, but in the last two years the average import has been only 110,000 lbs. The interesting case of Indian silk moths, cocoons, and other products, arranged by Mr. F. Moore in the Indian Gallery, deserves special notice by all interested in silk culture. [It is now in the India Museum, Whitehall.]

Since the opening of the ports of Japan a large quantity of silk has been received from thence. At first it realised from 15*s.* to 30*s.* The quality has not been found equal to the expectations formed at its early introduction; like China silk, its character has deteriorated, and it is now inferior in quality and much more mixed. The total imports here in the last three years have been 17,295 bales of 103 lbs. nett, of which 14,709 bales were taken by manufacturers. Lord John Hay shows raw Japanese silk, and Messrs. Remi, Schmidt and Co. have an interesting collection of the silks and cocoons of Japan. In the case of the latter, there are some very curious wild cocoons from Japan, especially a reticulated cocoon which appears to be undescribed, and the large green cocoons of the *Antheræa yama-maï*—the caterpillar, moth, and cocoon, of which have been figured and described by M. Guèrin de Meneville, in the Paris "Revue et Magazin de Zoologie for 1861." The value of the raw silk imported into this country from Japan in 1860 was £90,115, and the value of that received last year (1861) was higher, notwithstanding the decline in price.

The following is an approximate estimate of the production of silk in Japan computed by Mr. F. Howard Vyse, the British Consul at Kanagawa:—

Provinces.	Bales.	Disposition.
Sinchion	20,000	Half of this is sent to Miako market.
Djossion...............	5,000	The greatest part is sold at Kanagawa.
Aussion	45,000	Three-fourths of this is sent to Miako, the remainder to Kanagawa.
Mino	10,000	Three-fourths sent to Miako.
Etssion	5,000	Almost all to Miako.
Kanga..................	5,000	All to Miako.
Tanba, Tango and Tadzma	6,000	All to Osaka and Miako.
Deva	6,000	Three-fourths to Miako.
Itchizein..............	3,000	Almost all to Miako.
Itchingo...............	3,000	One-fourth is sent to Miako.
Kossion	3,000	The greatest part is sold at Kanagawa.
Boussien...............	2,000	Ditto.
Tchigondzein, Chingo, Tchikungo, Chizein and Oseumi	10,000	A part of this is sent to Nagasaki, the remainder is used at the place, or sent to Miako.
Noto	2,000	All to Miako.
Shida	10,000	Three-fourths to Miako.
	135,000	bales, 67,500 piculs.

Incidental mention may here be made of a collection of manufactured articles transmitted by Sir R. Schomburgk, British Consul at Bangkok. These are made, principally of silks, in the tributary states of Siam, the Lao country, which lies to the north of Siam proper, and borders the southern provinces of China, as Kiang-tung and Yunnan. The dress of the

men and women in the Lao country approaches more the Burmese than the Siamese. The women wear petticoats in lieu of merely the piece of cloth which is wrapped from the loins to the knee of the Siamese, leaving, with the exception of a shawl to cover the breast, the other parts exposed; and the men of the Laos tribes, generally speaking, are likewise clad in a more substantial manner than the Siamese.

The petticoats of the Lao are manufactured by women of the raw Chinese silks brought by caravans from the South of China. They are embroidered with gold thread and coloured silk, and are woven by hand looms in the most primitive manner; so rude, indeed, are they that the supports or posts of the machine are fixed into the ground under the shed, which at the same time serves as the principal habitation, or as an outbuilding. Here the woman sits before the loom, and guides the horizontal thread by means of the shuttle, with her hand. The same process is followed as regards the manufacture of the waist cloths for men, and the coarser cotton fabrics, as blankets or coverlets, hammocks, shirts, &c. The head cushions used are made of a softer substance than the head stool of the ancient Egyptians. They are sometimes richly ornamented.

ON SILK CULTIVATION AND SUPPLY IN INDIA.*

I have been asked to open up the subject of Silk Cultivation and Supply in India by a few remarks,

* Read at the Conference of the India Committee of the Society of Arts, April 2nd, 1869, Dr. J. Forbes Watson, M.A., M.D., F.L.S., Reporter on the Products of India to the

but when there are so many much more intimately acquainted with the subject than myself, I can scarcely tell why I have been selected to start the discussion of this very important question. It is one, at least, to which I have long paid attention, for it will be seen by reference to the "Journal" of this Society, that fourteen years ago in this room I spoke at some length on the subject of Indian silk production,* when Mr. Dickins read a most exhaustive paper on "The Commercial Consideration of the Silkworm and its Products." Strangely enough that gentleman and myself, who have not been thrown together since, are now associated as the active agents in a Silk Supply Association recently formed in London which has for its object the endeavour to stimulate and extend the production of that important raw staple, on which not only depends the prosperity of thousands in this country and on the Continent, but also the comfort and well being of operatives and labourers in far distant lands.

In 1808, at a meeting of the silk trade, held at Weavers' Hall, it was unanimously resolved "that Bengal silk has become highly necessary in many branches of manufacture, and that from experiments lately made it is found fit for purposes to which it had not before been thought suitable."

Secretary of State in Council, in the chair. For this Paper, which was translated and extensively circulated in the scientific journals of France, especially the "Revue des Cours Scientifique" of 31st July, 1869, and the "Bulletin of the Zoological Society of Acclimatisation of Paris," the Council of the latter Society voted me their Silver Medal in 1870.

* See the "Journal of the Society of Arts," vol. iii, p. 203.

Although our extended commerce with China and Japan has brought in largely-increased supplies from those eastern countries, and the production of silk on the Continent has been greatly stimulated, the demands for the civilised world are such,* that Bengal silk is

* M. Quatrefages, in the "Reports of the International Jury for the Universal Exhibition at Paris in 1867," published under the direction of M. Michael Chevalier, vol. xii, p. 430, furnishes some interesting statistics. I may insert here a table on the production of cocoons in various countries, given by M. Dumas in his "Report on the Process of Seed Production of M. Andre Jean," with the qualification that the figures in several instances are much below the truth, for however precise they might have been in 1857, they are widely different now. The figures represent millions of francs.

France	108,600	
Italy	281,500	
Other States of Europe, especially Spain	24,600	
Total for Europe		414,700
China	425,000	
India	120,000	
Japan	80,000	
Persia	23,000	
Other Countries of Asia	54,800	
Total for Asia		702,800
Africa		1,100
Oceania		600
America		500
Total		1,119,700

The estimate for America must be considered much too small when we take into consideration the attention that

more and more enquired for, and has materially improved. Much, however, yet remains to be done, both as to quantity and quality. Our total imports of silk last year (1868) were nearly 7,000,000 lbs., but this is 1,250,000 lbs. less than was received in 1858.

The silk of Bengal was originally inferior in quality and very carelessly wound. The East India Company, in 1757, sent a Mr. Wilder to improve the winding of silk, and in the year 1769, other Europeans as drawers, winders, reelers, and mechanics. The plantations were all in Bengal, and to the southward of 26° of north latitude, for the North-west Provinces were stated by Dr. Royle to be much too hot and dry for the silkworm.

Experiments were for many years made on the western side of India to introduce the culture of the silkworm, under an Italian, Signor Mutti, but they were abandoned, for want of success. Some excellent silk is, however, produced in Mysore, and it is probable that the culture might easily be carried on in the

has been given to silk production in North America, especially in Canada and California, and also in the tropical parts of South America, according to the reports made by M. Ant. Gelot to the Society of Acclimatisation, and facts furnished by M. Gomès de la Torre, respecting Ecuador.

With respect to Asia, we also agree with M. Quatrefages that the production is under-estimated; and in California, according to information furnished by the "San Francisco Herald," (quoted in the "Journal of the Society of Arts," vol. xvii, p. 378), the production of cocoons was, in 1868, 1,350,000, equal to 1,917 lbs, calculating 704 cocoons to the lb., representing 3,676 dollars; to which has to be added 10,800 dollars for seed eggs sold.

valleys of the Himalayas, and to these points I shall draw attention hereafter.

The Jury on Silk of the Paris Exhibition of 1855, remarked in their Report, "that the art of silk cultivation extended over the extreme portions of the Indian Empire. There skilful cultivators, seconded by large capital, had established for some years past improved establishments for reeling the silk from the cocoons." The silk shown among the other varied products of the East India Company, excited the warm attention of the Commission, and evidenced the great progress that had been made in reeling Bengal silk, previously thought impossible, by reason of the difficulties in the way of introducing the discipline necessary for the introduction of improvements in those distant regions. Looking at this progress, who can predict the future of silk in the East. China will soon have no barrier to oppose the pacific civilising conquests of European industry.

Messrs. Eaton and Sons inform me that the one great drawback hitherto attending Bengal silk is being rapidly decreased—namely, the manipulation of the cocoons by the natives. Now, on all sides, plantations worked by Europeans are starting up, and the natives, instead of winding off the cocoons which they produce, sell them to the proprietors of the plantation, and these being reeled upon the Italian system, silk is turned out fit to compete in many respects with that of the European production; but the cocoon being naturally a poor little thing, will never yield silk equal in nerve to the other sorts. Something may, however, be done by introducing new seed from

Japan—which, in all countries, seems to prosper well.*

In their last annual statement, Messrs. Durant and Co., speaking of Bengal silk, say: "The delivery is fully equal to last year, and this with a reduction of 20 per cent. in the supply; hence a considerable reduction in the stock, and comparatively full support of the improved prices for all the finer and better classes; the lower classes are at present almost unsaleable."

The average monthly delivery of Bengal silk during the last three years was over 641 bales. The average nett weight of a bale of Bengal silk is 150 lbs., but small bales weigh only 105 lbs.†

The late Mr. T. Winkworth, in his "Report to the Society of Arts on the Italian Exhibition at Florence in 1861," stated that there was received there from India and China (but principally from the former), and always in cocoons, about 984 tons annually, which at 2*s.* 4½*d.* the lb., would be worth about £241,000.‡

* I do not speak only of the ordinary silkworm (*Bombyx mori*), but also of other silkworms from Japan. Thus, numerous successful experiments have been made with the oak silkworm (*A. yama-maï*), in France, in Germany, in Switzerland, in Spain, &c. The raw silk produced by this worm is exported every day from Japan, and has commenced to be introduced into France in considerable quantities. On the silks of Japan and the commerce in silkworms' eggs, articles may be consulted in my "Technologist," vol. iii, p. 188, and the "Journal of the Society of Arts," vol. xvii, p. 60.

† See Dr. Forbes Watson's "Classified and Descriptive Catalogue of Indian Products," p. 100.

‡ The "Journal of the Society of Arts" has some interesting details on the trade in silk between France and Italy, vol. xvii, p. 94, and on the production of silk in Italy in 1868, vol. xvi, p. 853.

If we trace back the annual supplies of Indian silk, commencing with 1820, we find that the imports into the United Kingdom in that year were 1,206,722 lbs., or nearly one-half the total quantity received. The highest import reached was 2,116,596 lbs. in 1829. It subsequently averaged about 1,250,000 lbs. (with one or two exceptional years) until 1853, when there was a great fall to 586,662 lbs., and the later years, up to 1859, were not very much higher, except 1854, 1855, and 1858, which years averaged about 1,000,000 lbs. But this has to be explained by the entries made through Egypt, which swell the imports of Indian silk to from 3,000,000 to 5,000,000 lbs., or one-third to one-half of the total supply from all quarters.

Iu 1851 the quantity of silk exported from all India was 592 tons, value £619,318; 31 tons being shipped from Bombay, and all the rest from Bengal. Nearly all this was sent to England, a very little to France and the Arabian and Persian Gulfs.

In 1861 the total quantity exported was 873 tons, value rather more than £1,000,000 sterling. France received about 213,000 lbs. weight of this. Bombay and Bengal were still the only two exporting presidencies.

The value of the manufactured silk goods exported from India has largely declined. In 1851, 634,024 pieces, valued at £355,223, were shipped, nearly all to the United Kingdom. In 1861 only 211,542 pieces, of the value of £122,787, were exported; and in 1865 the value of the silk goods exported had dropped to £106,612. The principal seats of silk manufacture in India are the cities of Peshawur, Lahore, Umritsur,

Mooltan, and the capital of the neighbouring state of Bhawulpore. The silks of the latter place are considered the best, and the next those of Mooltan.

The value of the silk manufacture in the Punjaub was estimated twenty years ago at over £130,000, nearly half of that sum being expended on the raw material. At Umritsur there were 2,200 shops of all descriptions interested in the silk manufacture, the fabrics turned out being valued at £40,000. At Lahore there were nearly 1,000 shops, and the value of the manufactures was £20,000. In the Mooltan and Bhawulpore districts above £30,000 worth of silk goods were made, and nearly as much more in the Jullundhur and other districts. Little or no raw silk appears, however, to be produced in the Punjaub, a circumstance that seems singular, considering the apparent fitness of the soil, country, and climate, for the cultivation of the mulberry. The raw material employed at Lahore is chiefly brought from Bokhara or Affghanistan. The raw silks of Bengal and China are also made use of, the latter being procured from Bombay.

It is not improbable that the lower districts of the Punjaub were formerly silk-producing countries, as we know that in the time of Justinian silk was produced in Pirhind. A series of experiments was made a few years ago by the Government of the Punjaub, with a view of ascertaining whether silkworms could be successfully reared in the plains; but the experiment was a failure, the heat and want of sufficient moisture having rendered the worms nearly unproductive.

Notices regarding the extension of silk cultivation in the Punjaub have, from time to time, appeared in

India, and attracted considerable attention. The cultivation was originally commenced in 1862, at the suggestion of the then secretary of the Agri-Horticultural Society of the Punjaub, and most liberally fostered by the local and supreme Governments. Reasons (on which it is unnecessary to dwell) led to the experiments being given up. Shortly afterwards Mr. H. Cope, of Umritsur, brought the fact to notice that a native had successfully carried on silk cultivation in the Goordaspoor Zillah for years. This fact induced Mr. Cope to renew his attempts in 1860, when he obtained 3½ maunds of cocoons. Lord Canning sent the silk to England, where it attracted much attention. In 1862 the Punjaub Government again came forward; gave Jaffer Khan 500 rupees and 10 acres of land; also a grant of 2,000 rupees to Mr. Cope, to aid him in further attempts. He made a vigorous attempt in 1863, but failed for several reasons, none of which had any reference to climate. He persevered in 1864, and succeeded in obtaining 8½ maunds of cocoons, or nearly 700 lbs. At the same time other parties had been similarly successful. Mr. Scarlett's silk company at Peshawur obtained 1,200 lbs. of cocoons; other parties in various parts of the Punjaub, including the military stations at Gogama and Shahopere, succeeded in rearing silkworms, and the result was most encouraging. These experiments were subsequently carried on, and efforts were made to extend sericiculture to other localities, with fair promise of ultimate success. Mulberry trees were sent out in 1865 from Lyons at the request of Dr. Forbes Watson.

For more than thirty years Mr. J. Bashford, of Surdah, Bengal, has devoted his attention to the reeling of silk, and so successful have his efforts been in inproving the quality that the Society of Arts accorded him their medal. Although superior to much of the China reeled, yet it falls far behind the finest qualities of French or Italian silk. Animated with the desire of improving the cocoons in a country so abundantly furnished with mulberry trees, and every facility for breeding silkworms, Mr. Bashford introduced a quantity of the best eggs from France, Italy, and China, to cross with the poor races of Bengal, which breed all the year round. He did not desire to introduce an annual species, because that seemed destined by nature for cold climates, where the mulberry trees yield only one crop of leaves in the year, whilst in India the best trees shoot vigorously after pruning, and give, in five or six weeks, an abundant yield of fresh leaves. Although he has not yet had very great success in his experiments, he perseveres. The natives are, unfortunately, in the habit of stinting the worms in their food, and allowancing the leaves in such a manner as to injure the cocoons. Quantity of produce with them suffices; they give little attention to quality. The eggs are not sold in India as in Europe, but cocoons are bought for breeding from. Good and bad are purchased alike; no choice is made, and they are not rich enough to lose any; this is their reasoning. The houses in Bengal where the worms are raised have walls of earth or of matting, with thatched roofs. They are usually very small, and, notwithstanding the excessive heat, have neither windows, ventilators, nor anything

to give light, except a fine grating, which answers for a door. They pay no attention to light or temperature, and there is one good reason for this—without the protection of trellis-work the flies would enter and destroy the worms in two or three days; and, even with this protection, they do occasionally enter by millions, and penetrate into the chamber at the hour when the worms are fed. More than one collection of cocoons, which looked excellent at night, has been found destroyed in the morning by the worms escaping. In the times of extreme cold there may now and then be seen a fire at the door of the houses, but very rarely; and it is doubtful if even this is useful in buildings so badly ventilated. The variations of temperature are very considerable in Bengal during the year, and even in the twenty-four hours it is frequently 20°. There is no effort made to equalise the temperature in these houses, filled with worms, without necessary air, and giving out a pernicious odour.

In the words of a recent writer, Mr. P. R. Cola, in his essay, "How to Develope Productive Industry in India:" "It may be conceded that the production of raw silk is an important branch of industry open for future skill and exertions in many parts of India, and the duty of the English Government is to go on encouraging it by every possible means, as they are doing in France."

Messrs. Durant and Company, in their annual Silk Circular, give the statistics for a long series of years, from which I deduce the following figures, showing the

progressive imports of Bengal silk into the United Kingdom:—

YEARS.	BALES.*	PRICES.									
		Common.					Superior.				
		s.	d.		s.	d.	s.	d.		s.	d.
1830	8,726	10	0	to	12	0	14	0	to	16	0
1840	7,409	13	0	„	16	0	18	0	„	21	0
1850	10,295	6	0	„	10	6	12	0	„	15	0
1860	11,629	11	0	„	15	0	16	0	„	26	6
1870	13,543	13	0	„	17	0	23	0	„	29	0
1871	18,098	13	0	„	17	0	22	0	„	25	6

The decennial progress of our total imports of raw silk into the United Kingdom is shown by the following figures:—

	lbs.
1821	2,641,866
1831	4,621,874
1841	4,966,098
1851	6,597,178
1861	8,835,255
1862	10,434,350

Since then the total has dropped three or four million lbs. The imports in 1868 from the East, including China and Japan, were but 5,300,000 lbs. In 1870 they recovered to 6,307,000 lbs.†

* The average weight of the bales of Bengal silk is now 150 lbs. nett; from 1858 to 1860 it was 100 lbs. nett.

† The annual Reports of the Chamber of Commerce of Marseilles furnish the following statistics of the imports of silk and cocoons into France, for the six years ending 1867:—

	Silk, bales.	Cocoons, kilos.
1862	19,693	728,900
1863	24,502	743,400

Indian silk is classed into two kinds—namely, the rainy and the dry weather bunds; the name being derived from the season in which it is obtained. The inferior qualities of silk are generally used by local manufacturers; the better qualities are almost wholly shipped to Europe. This most valuable staple is capable of great extension and improvement. If its production were more carefully attended to it might rival the finest silks of Italy. There is no doubt that, with continued attention, the Punjaub would soon rival Bengal in the production of this important staple. The raw silks from Burmah, and some from Assam, are of a peculiar coarseness, yet the length and strength of the thread are such as to render this silk peculiarly adapted for the manufacturing of fringes. Experiments made in France with this silk will no doubt lead in a short time to the exportation of large quantities to Europe.

The worms, being badly fed, bred in quantities, in ill-ventilated houses, with little care bestowed on them, it can scarcely be expected that good cocoons would be obtained. There are, however, a few intelligent and careful breeders who obtain improved results, and 15 lbs. of their cocoons, or about 9,500 in number, will

	Silk, bales.	Cocoons, kilos.
1864	23,888	542,000
1865	39,542	654,000
1866	29,491	745,000
1867	32,000	579,000

The spread of the silkworm disease in the Levant, in Persia, and Damascus led to the fluctuations in the imports of silk and cocoons. Since 1865 the seed eggs have been principally obtained from Japan.

yield 1 lb. of very good reeled silk. The native breeders are generally very poor, and few raise more than 100 lbs. of cocoons each. Many produce far less, and often they exceed their means and starve their worms to arrive at this result. The production rests entirely with the natives, and the purchase of cocoons for winding is made by agents from house to house.

All the worms which produce silk in Bengal yield several crops of cocoons during the year, except one, an annual species of unknown origin, and which is dying out fast.

The principal kind, known under the name of Dessie, or Dasee, signifying "country," worm, is assumed to be an indigenous species. This furnishes nearly all the cocoons of the principal harvest of November, or that of the cold season, in Bengal, and yields the best silk. The cocoons are, however, small. In some districts the produce of the best quality is estimated at about 10,500 cocoons to 1 lb. of silk. The worm succeeds best in the cold season, and the cocoons are better than those of the succeeding gathering; but they continue, more or less, in different localities during all the year. The interval between the hatching of the egg and the formation of the cocoon is about thirty-six days in the cold season, but the time sensibly decreases as the heat increases.

The next species in order of importance is the Madrassee, and as this name signifies "brought from the sea," it may be concluded it is an imported species. It is very hardy, and is easily raised. The produce is slightly better than that of the Dessie worm,

since it takes only about 10,000 good cocoons for the pound of silk. The fibre is, however, less strong and brilliant, but it produces a very fine thread if wound with care. This worm passes so rapidly through its several stages, that twenty-five days suffice from the hatching of the egg to the full development of the cocoon. It will thus be seen that there are two distinct species of worm, suited by the wisdom of Providence to the different seasons.

The large worm known as Boroo Poloo is annual, and of unknown origin, for it existed when the East India Company sent out Italian eggs, all of which latter failed. It is principally met with now in the district of Radnagore. The silk it yields is excellent, and double that from the other kinds of Indian worms. But after frequent failures in the crop, irregular hatchings, and very expensive cost in breeding—besides being an annual worm—the natives have taken an aversion to it, and it is likely soon to be as rare at Radnagore as it is now in other districts.

We have seen that it takes at least 10,000 of the best Indian cocoons to produce a pound of silk, while in France about 2,500 will produce the same quantity. This great disproportion between the yield of Bengal cocoons and those of Europe must necessarily arrest attention, and the idea which naturally presents itself is that if India could produce cocoons equal in size to those of France and Italy the quantity of worms at present raised might supply the silk required by all Europe.

I may now summarise the principal silk-producing moths of India, and this I can well abridge from an

able paper by Mr. Frederick Moore, of the India Museum, published a few years ago in my scientific journal "The Technologist." *

* Mr. Frederick Moore, in his "Notes on the Silk-producing Insects of India and its adjacent Countries," (Technologist, vol ii, p. 410), Messrs. J. T. Ewing and Stutzer in their communication, "On the Cultivation of Silk in Tasmania," and Captain Hutton in his "Memoir on the Silkworms of India," include not only the silk-producing insects met with in British India, but study also those of the adjacent countries, such as the French and Dutch Possessions of the East, China, Japan, &c. They pass successively under review the *Bombyx mori*, *Bombyx sinensis*, *Bombyx Crœsi*, *Bombyx fortunatus*, *Bombyx arracanensis*, *Bombyx textor*, *Bombyx Huttoni*, *Bombyx religiosæ*, *Bombyx bengalensis*, *Bombyx Horsfieldii*, *Bombyx subnotata*, *Ocinara dilectula*, *Ocinara Moorei*, *Ocinara lactea*. *Ocinara comma*, *Actias Selene*, *Actias mœnas*, *Actias sinensis*, *Antherœa Paphia* (*Saturnia Mylitta*), *Antherœa Assama*, *Antherœa mezankooria*, *Antherœa surakarta*, *Antherœa Pernyi*, *Antherœa Roylei*, *Antherœa yama-maï*, *Antherœa Perrotteti*, *Antherœa Helferi*, *Antherœa jana*, *Antherœa Frithi*, *Antherœa Larissa*, *Saturnia pyretorum*, *Saturnia Grotei*, *Læpa Katinka*, *Neoris Huttoni*, *Caligula Thibeta*, *Caligula Simla*, *Caligula japonica*, *Salassa Lola*, *Cricula Trifenestrata*, *Attacus Atlas*, *Attacus Edwardsii*, *Attacus Cynthia*, *Attacus ricinus* and *Attacus insularis*.

Those who would study with care the family of the *Bombycidæ* should consult, among others, the "Notes on the Indian Bombycidæ," by Captain Hutton, in which he divides this family into three groups; the group *Tussah*, the group *Eria*, and a third group containing the genera *Læpa*, *Saturnia*, *Cricula*, *Salassa*, and, perhaps, *Brahmora*, which may probably be again sub-divided later into three or four groups. In these notes Captain Hutton examines with care the characteristics of the genus *Attacus*, passing under review *A. Cynthia*, *A. ricinus*, and *A. Edwardsii*. It is to India that we owe *A. Paphia* or *Mylitta* and the *Attacus ricinus*, which has

The common mulberry silkworm (*B. mori*), doubtless introduced from the northern provinces of China, produces only one crop annually, but spins the largest cocoon and the best silk, of a pale yellow.

There is another species (*B. sinensis*), the small Chinese monthly worm, introduced into Bengal about thirty or forty years ago, but now fast disappearing, being very delicate.

The Madrassee, or Nistry worm (*B. Crœsi*), yields in Bengal and China nine crops of a good golden yellow silk. Introduced into India about 1780, it is degenerating by reason of carelessness and improper management of the worms. Cocoons monthly between November and June, if attention be paid, but more generally from January to May.

The Dasee, or country worm (*B. fortunatus*), yields a golden yellow silk, and produces several crops annually—stated to cocoon five times in the year, at periods from forty to a hundred and ten days.

been so much experimentalised upon in France. From other parts of Asia France has introduced *Attacus Cynthia*, the Alianthus silkworm, the *Antheræa Pernyi* or oak silkworm of China, and the *A. yama-maï*, or oak silkworm of Japan. But it is not only from Asia that we should seek to obtain auxiliaries to the common silkworm, and other countries may be explored with advantage. North America could offer us the *Bombyx Laocoon*, *A. luna*, *A. Selene*, *A. ceanothi*, *A. Prometheus*, *A. Polyphemus*, and *A. Cecropia*. This last species has already been submitted to many trials. South America can furnish *A. aurota*, and *A. hesperus*. Madagascar has its *Borocera Cajanus* and other species little known, among which are found cocoons like those formed by *Bombyx processionea*, contained in great silk purses, serving as nests for whole colonies of caterpillars.

The Arracan silkworm (*B. arracanensis*) yields annually several crops of silk, superior to that produced in Bengal.

The Boroo Poloo (*B. textor*) produces a pure white cocoon, spun in March and April. The life of the worm is from forty-two to fifty days, and the cocoon lasts from ten to fifteen days.

A wild mountain species (*B. Huttoni*), found abundantly feeding on the indigenous mulberry in the forests of the North Western Himalayas, produces decidedly good silk, and in considerable quantities, which would be valuable. The worm, however, has hitherto proved so intractable that it cannot be reared in the ordinary way in the house, and thrives only upon the trees in the open air.

The caterpillar of *Actias Selene* feeds on many wild plants, and can be easily domesticated. The cocoons in Pondicherry are softened in a solution of wood ashes, taken out, picked, and immediately spun, without being either combed or carded, the silk being exceedingly strong, tenacious, elastic, and brilliant. Four broods can be produced annually.

The Tussah (*Antheræa Paphia*) is one of the most common in use of the native wild silkworms. It is found in abundance over Bengal and the adjacent provinces, and has afforded to the natives from time immemorial an abundant supply of a most durable silk. Millions of the cocoons are annually collected in the forests and taken to the silk filatures near Calcutta, but the principal place of manufacture is at Bhagulpore. Tussah silk is everywhere used as clothing by the natives, and even by Europeans, while considerable

quantities of woven Tussah are imported into England.

Tussah silk has been thrown with some success in England. In the Indian Department of the London Exhibition of 1862 some goods manufactured from this silk were shown, which were very fine in texture; but being woven from the raw material they do not take the dye well, and hence cannot compare with the silk of the *Bombyx mori*.

Tussah moths are hatched twice in the year, in May and August. The larvæ go into the chrysalis state in September, remaining so till the May following; whilst those that enter the chrysalis state in July come out in three weeks. Many of the females lay eggs in eight or ten hours after quitting the chrysalis; others, again, do not until the following night, or longer. In ten days the young larvæ make their appearance, and feed on the Asseen and Saul trees. In about three weeks from the time of the exclusion from the egg they attain their full size, and in eight or ten days more prepare for their transformation into the chrysalis. The caterpillar commences its operations by drawing a few leaves slightly together, as if to screen it from observation. It then spins a strong cord, composed of many threads, altogether about the thickness of a crow-quill at the end of which it weaves the cocoon. This is so transparent for the first six-and-thirty hours that the larva may be distinctly perceived at work in the interior. After that time the cocoon gradually acquires consistence by the continued industry of the caterpillar. and becomes quite opaque, from the addition of a glutinous liquid with which it

moistens the whole. When that dries, the cocoon appears as if covered with white powder, and in the course of a couple of days becomes perfectly hard. The moth generally deposits its eggs within a few yards of the cocoon; these the villagers collect and keep in their houses till the young caterpillars come forth, when they are placed on the Asseen trees in the jungles, the proprietors remaining to protect them from the birds, and to bring home the cocoons when perfect. The people who rear these silkworms are of the Sontal and Bhouree castes, and practise many superstitious ceremonies while tending them in the jungles.

From the experiments of M. Perottet, of Pondicherry, it would appear that the statement that this moth cannot be domesticated is fabulous, as he succeeded in inducing it to breed in a state of captivity, and obtained sound and productive eggs. He managed during a period of abundant rain, and when there was a continued damp atmosphere, to obtain four generations of these worms during the year. M. Perottet forwarded to France living cocoons of this species, and several generations were reared there, being fed on the leaves of the common oak, which were greedily eaten by them. During the early part of 1859 he sent five different despatches of living cocoons of this worm to France, which arrived safely and were doing well.

The cocoons found upon the *Terminalia* are always considered stoutest and strongest, while those on the jujube are the weakest. 50 cocoons obtained from the former tree will weigh one French lb. These cocoons are exceedingly rich in silk; they reel by

means of an alkali or any other solvent with great facility, and to the very end. The silk they produce is most elastic and of singular brilliancy, but dark in colour.

There has been some discussion as to the distribution of this species of moth in India; the difficulties having arisen mainly from the existence of allied species in Darjeeling and other remote localities.

Dr. Roxburgh, in the seventh volume of the "Linnæan Transactions," has described the preparation of the Tussah silk; and Colonel Sykes, in the third volume of the "Transactions of the Royal Asiatic Society," has a paper on the cocoons of the *Saturnia Paphia*, or *Antheræa Paphia*.

Tussah silk could be obtained in large quantities in the wild tract of country to the eastward of the Godavery river. The breeding worms in the cocoons are there preserved in the houses. At the proper season, the young caterpillars are taken to the jungle and placed on wild trees, where in time the cocoons are formed. Demand would encourage supply to an unlimited extent. If this coarse kind of silk would sell in Europe the whole jungle would unfold its treasure, and a very large quantity might be brought into the market annually.

The Tussah cocoons brought from Cuttack vary much in size and colour, and there is also a very perceptible diversity in the texture and glossiness of the raw silk, which, most probably, depends on the species of tree on which the caterpillar may happen to have fed. The same variety is observable in the female moths, which are of three or four different sizes and

colours. The mode of winding off the thread does not differ from that pursued in the case of the ordinary silkworm proper. The Tussah silkworm feeds indiscriminately on the teak, the jujube, the mulberry, and other trees. In some places it is an annual only, but in Bengal it has at least three broods in the year.

The Moonga silkworm (*Antheræa assama*) feeds also upon several wild trees, among others *Tetranthera Diglotia* and *Tetranthera macrophylla*; it is often cultivated by the natives, and can be reared in houses, but is fed and thrives best in the open air and upon the trees. There are five broods in the year. The silk forms one of the principal exports of Assam, and leaves the country generally in the shape of thread.

The Mezankooree, a closely allied worm (*A. mezankooria*), also feeds on a species of *Tetranthera* in Assam. The silk is nearly white, its value being fifty per cent. above that of the Moonga, and it constitutes the dress of the higher classes in Assam. The oak-feeding silkworm of North West India (*A. Roylei*) feeds on the common hill oak (*Quercus incana*). The cocoon is large and very tough, and the silk is pronounced as promising, and worth cultivation. An allied species (*A. Pernyii*), has been introduced into France from China.

The Atlas moth (*Attacus Atlas*), the caterpillar of which feeds on the leaves of *Falconeria insignis*, *Bradleia ovata*, &c., is stated to produce the Tussah silk of China. It is easily reared in a state of domestication, producing a cocoon well stored with a fine, yet strong silk, of a greyish colour.

The *Attacus Canningii* is the wild sub-Himalayan

Eria silkworm, feeding on *Coriaria nepalensis*, *Xanthophyllum hastile*, and *Ricinus communis*. In its native country, the lower Himalayas, it is an annual. It was discovered in its wild state at Mussooree in 1844 by Captain Hutton.

Attacus ricinus is the commonly cultivated *Eria* or *Arindy* silkworm, which, in Bengal, yields four or five crops annually, and is reared over a great part of Hindostan in houses in a domestic state, feeding on the leaves of the castor-oil plant. It gives a cloth of seemingly loose texture, but of incredible durability, the life of one person, it is stated, being seldom sufficient to wear out a garment made of it. The thread is woven like cotton, and the cloths are mostly used for home consumption by the poorer classes at all seasons, and by the highest for winter wear. Fabrics made of these wild silks were shown in the Indian section of the London Exhibition of 1862. (See "Descriptive Catalogue of Indian Products," p. 217.)

These wild silkworms may be thought by many unworthy of notice, as they do not yield that kind of silk most valued in commerce, but they are more important than they at first appear to be. We must remember that the culture of some in the forests, and the collection of all, affords employment to considerable numbers of the natives in the parts of districts least productive of useful occupation. They afford also clothing for many of the inhabitants. In one district alone, that of Azimghur, it was stated that, in 1837, 318,772 pieces of Tussah silk were turned out annually from the looms.

The enquiry as to which is the tree best adapted in

India or elsewhere for the production of good silk, although apparently a very simple one, is in reality not easily answered, since much must depend upon the species of worm under cultivation, as well as upon the climate itself; and the difficulty is enhanced by the fact that every one who, possessed of much zeal but little knowledge of the subject, essays to rear silkworms, appears to think it necessary to extol some particular species of mulberry, and to pronounce it for the time the *ne plus ultra* of silkworm diet. One while it is the white-fruited mulberry only that can enable the insect to elaborate good silk; and anon, for some inexplicable whim, the white is discarded, and another tree adopted in its stead. The purple-fruited species is unhesitatingly denounced; and yet the white mulberry is found to be nothing more than an albino variety of the purple-fruited tree.

In the Report of the Agri-Horticultural Society of Calcutta, for 1866, notice is taken of the experiments in various parts of Bengal with the varieties of the Japan silkworm, which are stated to yield a much superior silk to the monthly worm of Bengal, and samples raised from this stock at Ghotal were considered by Mr. Turnbull as infinitely superior to the general run of Radnagore silk and not far short of Italian. In consequence of this favourable result further supplies of eggs were ordered, and the experiments continued.

The cultivation of the silkworm in Oude is believed to be capable of great extension, as the mulberry abounds throughout the province, and the climate appears to be favourable to the rearing and thriving

of the worms. Of silk from Oude shown at the London Exhibition in 1862, Messrs. Durant reported that it was, in some respects, better than the silk of Bengal, inasmuch as it had more nerve and less of the fluffiness which, more or less, seems to be an inherent condition of even the best of the European filatures of that country.

In 1861 Dr. Bonavia commenced the cultivation of various kinds of mulberry trees in Lucknow, distributing cuttings to the officers of all the districts in Oude, and energetically induced the natives to rear silkworms. After repeated trials, he stated in 1865 that his experiments were given up, for it was found that *multivoltine* varieties required more care than any native would be inclined to give them, in a climate like that of Oude, where the contrasts of temperature between different seasons are so great. The *univoltine*, or annual variety, also, did not succeed sufficiently well to give much encouragement. He further states, that if silkworm breeding is ever to succeed in Oude, it must be some hardy annual variety, feeding on the native mulberry.

The cocoons of Oude and Umritsur are said to have degenerated in one season 56 per cent. below the Cashmere standard. Cocoons raised at Lucknow, in Oude; by Dr. Bonavia, required 5,200 to the lb. of silk. At Candahar, in 1849, the Affghans reckoned about 4,500 to the lb. of silk; while in France, previous to the late epidemic, 2,500 cocoons were, on the testimony of Mr. Bashford, equal to a lb. of silk. Here, then, we have positive evidence that the climate of the Punjaub and other parts of the plains of India

is injurious to the health and general well-being of the insect.

The political resident at Munnipore, writing in 1864, states that there can be no doubt of the suitability of the climate of that locality to the growth of the finest quality of silk.

With the sanction of Government, an experiment was instituted by Captain Thomas Hutton, at Mussooree, in the North Western Himalayas, in 1850, having for its object the eventual cultivation of the wild Himalayan silkworm, known as *Bombyx Huttoni*, and for this purpose he was instructed to form a plantation of the indigenous mulberry trees, three years being granted in which to finish the work. Subsequent trials proved unfavourable to the chance of future success with this species. Captain Hutton, however, represents that experiments tried with the domesticated Cashmere and Bengal Madrassee worms has proved, beyond a doubt, not only that these worms throve well in the climate of Mussooree, but that there was also a ready and remunerative market for the silk.

"Is it not," asks Captain Hutton, "a well-understood and long-established fact that, whether among animals or plants, an occasional renewal of seed, and reinfusion of the original stamina is found to be absolutely necessary for the preservation of health and of that particular standard of perfection which it is thought desirable to maintain? And yet, with the domesticated *Bombyx mori*, this necessary precaution has been uniformly neglected for 400 or 500 years. What wonder, then, that under the combined effects of bad and scanty food, want of sufficient light and venti-

lation, too high a temperature, and with the constant and unvarying interbreeding of a debilitated stock, the insect should have become subject to a multitude of maladies, and threaten, at no distant period, to become extinct."

As early as the year 1791 experiments for the introduction and culture of what succeeded so well in Bengal, were made in the Presidency of Madras, and continued for several years, but without any permanent results; as in the year 1854 only 1,666 lbs. of silk were exported. This is probably owing to the climate of the Madras Presidency being generally unsuited to the culture; for, in the more elevated climate of Mysore experiments have been continued to the present time, and some very good specimens of silk were sent to the Exhibitions both of 1851 and 1855; also to the Exhibition held at Madras in 1857, when it was stated as probable that the culture might be successfully carried on in the valleys of the Neilgherries. The silk produced in Mysore is required for the manufacture of the silk shawls of that province.

In the same way experiments were made in the Bombay Presidency about the year 1755, repeated again in the Deccan in the year 1830, and persevered in for ten years, under the superintendence of an Italian, Signor Mutti, but without eventual success, as was always anticipated by Dr. Gibson, in consequence of the heat and dryness of the climate.

Though these instances may appear to put limits to the extension of silk culture in India, and to a supply of raw material from that country; they only do so in the districts having the climate which has been

indicated. In the valley along the foot of the Himalayas, in North Western India, there is a less arid soil, a more temperate climate, and species of mulberry appear indigenous and flourishing. This is still more the case in the lower hills which bound the Punjaub and in many parts of the Punjaub itself. Here, indeed, a most successful experiment has been commenced, of which the results were shown in the Paris Exhibition of 1855.

Experiments were for some time energetically carried on by the late Mr. Cassamajor and by Major Minchin. Silk from Italian worms was successfully reared at Katy, and silk was produced of good quality on the estate of Mr. F. Lascelles on the Neilgherry hills. Quantities of silk may be looked for yet from these localities; from Assam, Bokhara, and Affghanistan, whilst the dry and equable climate of Scinde is especially favourable to silk culture.

The cultivation of the mulberry in connection with the manufacture of silk has been carried on for many years in the talooks lying in the vicinity of Bangalore, Mysore, and Seringapatam, where are chiefly congregated the Mussulman communities, to whom this branch of industry is almost wholly confined. Devoid of energy, and unaided by the capital which could enable them to import varieties, both of the mulberry and the silkworm, they have been content to eke out a bare subsistence, and, indeed, from the rapid deterioration which has been going on in both respects, the local trade has been for some years in a languishing state. The establishment, however, of a Silk Filature Company, conducted by an Italian gentleman at

Kengari, near Bangalore, and the introduction of new breeds of silkworms, as well as of improved kinds of mulberry, promise to inaugurate a new era in the silk manufactures of Mysore. The increased demand thus occasioned has given a stimulus to the production of a better kind of silk, and, in order further to promote this object, arrangements were made, in 1865, with Signor de Vecchi for the importation of silkworms' eggs from Japan, for distribution to those who were willing to rear them with care, and to give the experiment a fair trial. The only kind of silkworm hitherto reared in the Mysore country is the China variety.

These worms yield cocoons which are described as being much inferior to those of China and Japan; the silk is not closely woven, and is internally flossy, though the quality of the thread, when reeled by European processes, is found to be good. The inferior quality of the native-reeled silk is evidenced by the value. The best samples, which are worth on the spot 4 or 5 rupees (8*s.* or 10*s.*) a seer (equal to three-fifths of a pound), would not in Europe obtain a higher price than 13*s.* or 14*s.* per lb.

Some singular religious notions stand in the way of the extended production of silk by the natives of the East. Thus, Mr. Wright, of Peradenia, near Kandy, Ceylon, after making exertions to extend the culture of the silkworm, and forwarding 500 or 600 cocoons to be distributed among the natives, called the headmen to assist, but they doubted whether the priests of Buddha would sanction the cultivation of the silkworm. The high priests were convened, and came to the meeting in their large yellow silk shirts—their sacer-

dotal dress; but nothing could induce them to recommend an occupation which involved the destruction of life. "Why," said the agent, "you come here, wrapped in the spoils of the worms that are killed by the strictest Buddhists in China and Siam!" But they would not sanction a practice which involved the destruction of the worm, although they themselves gave the greatest encouragement to it by the use of silk.

Silkworms are common in many parts of the province of Burmah. In the district of Sandoway the eggs are hatched by the ordinary heat of the weather throughout the year, and a supply thus kept up, but the silk procured, not being good at all times, it is not until December that the silk for sale is obtained. In that month the worm is largely bred, and the cocoons are formed in February. No selection is made of the best silk, but it is sold indiscriminately, and used in the district in the manufacture of native dresses.

Silkworms are also extensively reared in the northern and western parts of Toungoo. Attempts have been made to introduce a better breed of worms, by importing eggs from Moorshedabad in Bengal.

I have now somewhat hastily skimmed over the extensive subject of silk production in India.

Imperfectly as this has been done, I trust it will open up a field of inquiry and provoke discussion which may result in benefit hereafter to that great and important dependency of the British Empire, as well as in supplying the urgent wants of the factories of Europe. The Society of Arts has long devoted its best energies

to this subject, and it is to be hoped that this appeal, made for further detailed information, and for useful suggestions as to the best mode of stimulating the production and improving the quality of Indian silk, may not have been made in vain.

THE PRODUCTION OF SILK.*

The silk trade in Europe generally is languishing, owing to the long-protracted effects of the disease in the silkworm. Up to 1824, the period of the removal of prohibitions by Huskisson, and after many ages of protection, the silk industry in England may be said to have merely vegetated; and the number of looms for weaving ribbons and stuff never exceeded 24,000. Six years after the removal of the prohibitions, viz., in 1830, there were 50,000; and in 1855 the number exceeded 100,000. In 1862, judging by the quantity of silk taken for consumption, there were more than 150,000, producing manufactures of the value of £12,000,000, of which the sixth part only was exported.

Raw silk has advanced in price enormously of late years. There are no sumptuary laws now in existence restricting the use of silk to any class, and it is worn more or less by all ranks of society in most countries; indeed, with the spread of wealth, its more extended use is only retarded by the extravagantly high prices.

The stagnation and decline in our own factories is

* Published in the "Journal of the Society of Arts," November 26, 1869, vol. xviii, p. 26.

shown by a comparison of the two last official returns of the Factory Commissioners. At the close of 1861 there were 771 silk factories at work in the United Kingdom, with 1,338,544 spindles and 10,709 power looms, giving employment to 52,429 hands, of whom about 37,000 were females. At the end of last year (1868), there were but 591 silk factories, with 1,159,706 spindles, and 14,625 power looms; these employed 41,017 hands, of whom about 29,000 were females. Many of these factories have since been closed; and we thus find more than 12,000 persons, formerly profitably engaged, have been thrown out of employ, and 180 factories closed in the past seven years.* This tells terribly upon the great centres of the silk industry—Macclesfield, Coventry, Manchester, &c.; but the Continent, which gives more attention to silk manufacture, is suffering equally with ourselves from a deficiency in the supplies of this important trade material. Silk production has been sorely tried also in France during

* SILK FACTORIES IN THE UNITED KINGDOM AT THE CLOSE OF 1861.

	Factories.	Spindles.	Power Looms.
England and Wales ...	761	1,305,910	10,635
Scotland	8	31,452	60
Ireland	2	1,182	14
	771	1,338,544	10,709

There were then 7,279 power-loom weavers. The amount of power was 6,186 steam and 864 water. The number of persons employed was 52,429, of whom 36,899 were females.

the last twelve years. In the greater number of the Departments, where the rearing of the mulberry formed considerable riches, there reigns a general desolation.

Of the various countries which give attention to silk production, Italy and France stand in the first rank, and their winding and throwing establishments have rapidly increased, each country contesting which can turn out the best productions. Austria follows in the movement; Turkey and Russia are not strangers to progress; while Spain also produces silk of a good quality.

The quantity of silk produced by France and Italy is much more considerable than that of all the other States of Europe; but attention has of late

There were 249 spinning factories and 423 weaving factories. Parliamentary Return, February, 1862.

SILK FACTORIES, 1868.

	Factories.	Spindles.	Power Looms.
England and Wales ...	587	1,148,408	14,511
Scotland	2	11,298	108
Ireland	2		6
	591	1,159,706	14,625

There are now 6,329 power-loom weavers. The moving power employed is 5,879 steam and 649 water. The total number of persons employed in the factories is 41,017, of whom 28,840 were females. 196 factories were engaged in spinning; 316 exclusively in weaving; 56 combined spinning and weaving; and there were 23 not included in either of these descriptions.

years been much directed to the seats of production in Eastern Russia, Turkey, and Japan, which have not been attacked by the fatal disease which has proved so injurious to the silkworms of parts of Europe. In 1853 the production of cocoons in France was about 26,000,000 kilogrammes (of 2⅕ lbs.). This represented at least 2,000,000 kilogrammes of raw silk, of the value of 150,000,000 francs. In 1854 and 1855 the production began to decline to under 20,000,000, the disease called pebrine having manifested itself in the worms. In 1856 the evil increased; the rains were heavy; the crop of cocoons did not exceed 8,000,000, and the price reached the unheard-of figure of 7½ to 7¾ francs per kilogramme. From 1857 to 1860 the production stood at about 9,000,000 kilos. In 1861 and 1862 the production again fell, and so continued, notwithstanding the introduction of new seed from Japan; until in 1865 it had declined to about 5,000,000 kilogrammes of cocoons, and the price rose to 7 francs and 9 francs the kilogramme. Prices have since then even gone higher, 8 francs and 10 francs being asked and paid.

In 1866 all the efforts of Europe were turned to the introduction of healthy seed from Japan, more than 2,500,000 ozs. of eggs having been shipped from there to various countries. Unfortunately, a very mild winter brought forward the eggs too soon, and a great loss was sustained, so that instead of the production anticipated, the crop in France did not exceed 10,000,000 or 11,000,000 kilogrammes of cocoons. In 1867, about 2,000,000 cards (each card contains on the average 25 grammes) of silkworms' eggs were

shipped from Japan, of which three-fourths were for Italy, and the rest for France. The amount of insurance effected on these while in transit was something enormous. Considerable loss and inconvenience were experienced at first by extensive frauds perpetrated. The eggs of Chinese silkworms were sent over to Japan and there re-packed under the seal of the French Consulate, fraudulently obtained or imitated, and this was sent off to Europe as pure and healthy Japanese seed.

The import and export figures speak prominently and forcibly as to the importance of the silk industry in France. The average annual value of the silk imported into France from 1837 to 1846 was 60,000,000 francs, from 1847 to 1856, 122,333,333. In 1860 it was 260,500,000; in 1865, 429,000,000; and in 1866, 383,000,000. The raw silk exported was to the value of 45,000,000 francs in 1859, and 107,000,000 in 1865.

The value of silk goods of all kinds exported was 1,347,000,000 francs, average 1837 to 1846; 2,747,000,000 from 1847 to 1856; 4,548,000,000 in 1860; and 4,677,000,000 in 1866. In 1862 the value of the silk manufactures, &c., locally used, was set down at 220,000,000 francs, and of those exported at 440,000,000; making a total of 660,000,000 francs. The products of the French silk manufacture can now scarcely be estimated at less than £40,000,000 sterling. The value of our imports of French silk manufactures has increased £6,250,000 since 1860. There are stated to be about 2,000,000

workpeople directly or indirectly interested in silk production and manufacture in France.

The quantity of raw silk produced in Italy, before the outbreak of the silkworm disease, was 3,710,000 kilogrammes; since then it has yearly decreased, and in 1868 it only reached 1,900,000 kilogrammes, or little more than half. But this is not all. About 10 to 10½ kilogrammes of silk used to be obtained from 100 kilogrammes of cocoons in Tuscany; now it is with difficulty that 7¼ to 7½ kilogrammes of silk are obtained from the same quantity.*

* The following tables show, A, the total yield of cocoons in Lombardy in 1869, with the highest and lowest prices of the different qualities per myriagramme (22·04 lbs. avoirdupois), in Italian lire (26 to the £); and, B, the produce of silk in Italy and the Tyrol in 1868 and 1869, compared with the annual production before the outbreak of the silkworm disease.

TABLE A. Provinces.	Total quantity of cocoons produced, in myriagrammes.	Price of Cocoons. Annual. Lowest.		Price of Cocoons. Annual. Highest.		Price of Cocoons. Bivoltine. Lowest.	Price of Cocoons. Bivoltine. Highest.
		l.	c.	l.	c.	l.	l.
Milan, with Lodi	240,000	45	0	71	50	30	40
Como	360,000	60	0	75	0	30	40
Bergamo	300,000	50	0	65	0	30	40
Brescia	240,000	40	0	62	50	30	40
Valtellina (Sondrio)	60,000	52	50	70	0	30	40
Pavia	120,000	35	0	60	0	10	30
Cremona	240,000	37	50	52	50	10	30
Mantua	120,000	40	0	55	0	10	30
Total	1,680,000	35	0	75	0	10	40

The yield composed of two-thirds Japanese eggs imported direct, and one-third reproductions in Italy.

In Russia, the total production of silk fabrics exceeds £2,500,000 sterling. In Switzerland two or three small cantons employ about 60,000 looms, and export silks and ribbons to the value of £4,000,000 sterling to England and North America.*

The German Customs' Union is, however, closed to foreign silk manufacturers, since they possess factories which work from 10 to 15 per cent. cheaper.

Although the production of silk extends in China over all the zone comprised between the 37th and

TABLE B. Provinces.	Total Quantity of Raw Silk in Kilogrammes.		
	Before outbreak of silkworm disease.	In 1868.	In 1869.
Piedmont, Liguria, Sardinia	515,000	247,000	360,000
Lombardy	1,310,000	788,000	917,000
Parma, Piacenza	32,000	10,500	12,000
Modena, Reggio, Massa	43,000	16,000	18,500
Romagna	} 205,000	22,500	27,000
Marches		32,500	39,000
Umbria		5,000	6,000
Tuscany	140,000	40,500	46,500
Neapolitan Provinces	353,000	58,000	58,000
Sicily	163,000	34,000	34,000
Venetia	700,000	453,000	462,000
Tyrol	250,000	193,000	170,000
Total	3,710,000	1,900,000	2,150,000

* The silk manufacture of the United States in 1871 was represented to be as follows :—The capital invested, 25,000,000 dollars. It afforded employment for 16,000 operatives, three-fourths of them women and young persons, for whom such employment is specially adapted, being clean, light and healthy. The wages paid these operatives amounted to 7,200,000 dollars per annum, being a weekly average for women of 7 dollars, and for males 12 dollars.

23rd degrees, and more especially between the 33rd and 29th, no part produces it so abundantly as the province of Tché-kiang, which is equal to that of all the rest of the empire. If, in a good average year, China produces 120,000 bales, it may be said that Tché-kiang furnishes 60,000. But as it is the departments in the north of the province, and those which approach to Shanghae, that produce the largest part of this silk, there comes to Ning-po only what is raised in the plains of Shaachin, which before the rebellion, yielded 10,000 bales. In 1863, the export was but 50 piculs; in 1864, 949; and in 1865, 1,914. A part of this silk, of too inferior a quality for Europe, is used up for native fabrics. The silk manufacture constitutes one of the principal industries of Tché-kiang, and especially of the capital, Han-tchéou. There was exported in 1865, to the value of 1,794,000 francs, against 102,000 francs only in 1864, a proof of the increase of prosperity of the silk industry in Tché-kiang.

THE IRON MANUFACTURE.*

Iron enters into such general use in every occupation, and in all countries advanced beyond the first step of civilisation, that it may well take rank with us amongst the necessaries of life.† In no country of the

* Published in Lawson's "Merchants' Magazine," London, 1852.

† "There could be no effectual civilisation without iron. From the moment that a people acquires the art of making it malleable, they cease to be savages, and, in proportion as they acquire skill in its fabrication, they may be said to be civilised. Fortunately for mankind, therefore, iron is the most abundant, the most widely diffused, and the cheapest of all the metals. It is at the same time the most difficult to reduce from the ore to the metallic state, and yet, with the exception of the savage tribes of America, of Australia, and of the islands of the Pacific, the art has been in possession of nearly all the other peoples of the world for at least 3,000 years—in possession of some who could neither extract a saccharine matter from vegetables, nor a spirit from grain.

Let us try and furnish our readers with a popular sketch of the history of that metal, from which is fashioned the lady's needle, the sheet-anchor and chain-cable of a first-rate, the steel pen, the steam-engine, the Menai bridge, a saucepan, Mr. Russell's great steam-ship of five times the burden of a first-rate, and lastly, the needle of the compass that will enable that monster steamer to cross the broad Atlantic or broader Pacific.

Except in meteoric stones, in some of which it has been found, according to Humboldt, in the proportion of 96 per cent., there is no such thing in nature as iron in the metallic state. All of it is made from rough stones, nearly useless

world has the iron manufacture been carried to such a degree of perfection as England; in no quarter of the

for any other purpose, and, in reference to agriculture, mere indications of sterility in the soil. Iron ores either consist of oxide of iron, or they are made to consist of them by calcination, and these oxides are combined with more or less of earthy matter, consisting chiefly of alumina or clay, and of silicon or the earth of sharp sand. The calcined ore placed in the blast furnace in alternate layers with carbon or charcoal and with lime, yields iron by the union of the carbon with the oxygen of the ore, and of the lime with its earthy matters. The metallic product obtained is the unmalleable, intractable material, appropriately called pig or cast iron, and this by analysis is proved to consist of ninety-five parts of iron and five of carbon. By getting rid of four parts out of the five of the carbon, we have steel, and by getting rid, as far as practicable, of the whole of the carbon, we have malleable iron—the two substances with which man has subdued the world.

But, besides carbon, all iron ores contain two other substances destructive of the quality of malleable iron and steel, namely sulphur and phosphorus, and these must be got rid of from the cast iron. This, whatever be the process pursued, is effected by causing all the inflammable matters in the cast iron to combine with the oxygen of the atmosphere. This is comparatively easy when the ore is pure and the fuel wood-coal; but with us who work with an impure ore and with coke, or charred mineral coal, both of them containing phosphorus and sulphur, the process is tedious and difficult. The molten metal is first placed in the refining, and thence conveyed to the reverberatory furnace, after which it is subjected to the operation of what is technically called "puddling." This consists in raising the half-molten metal on the end of an iron bar, so as to expose as much of its surface as possible to the air, in order to the consumption of its carbon, sulphur, and phosphorus, by combining them with oxygen. The operation is performed by workmen nearly naked, who, when engaged in their hard toil, present very much the appearance of naked

globe has it been so extensively practised, or its production so largely desiderated. In every portion of the peopled earth are to be found its machinery or its articles of domestic use—representatives of some one of its infinite varieties or modifications—from an iron skewer or a pin to an elaborate steam engine.

The iron trade especially deserves pre-eminence in a consideration of our industrial arts; for great and mighty interests are involved in the continued advancement and prosperity of this important branch of manufacture. Not only the subsistence, but the physical condition, of our integral population depends mainly on the progress of our metallic industry. To this continuance and success civilisation must owe its greatest advances, its mightiest enterprises; for our country's genius is purely mechanical, and by her steam, her iron, and her machinery—inventions and contrivances to save the sinews and muscles of man—is she working out, not only Britain's redemption, but the redemption of the world from political slavery, and social and moral degradation. Our Iron Trade

savages, with firebrands in their hands, dancing at night round a fire in the performance of some diabolical rite.

Ferrum *exercebant* vasto Cyclopes in antro,
Brontesque, Steropesque, et *nudus* membra Pyrachmon.

One might almost fancy that Virgil had seen the operation of puddling. By the invention of Mr. Bessemer, the whole of this tedious and barbarous proceeding, from the time the metal comes from the blast furnace until it is subjected to the hammer and roller, is superseded. By a furnace of his own invention he causes a stream of atmospheric air to pass through the mass of molten metal, as it comes from the blast furnace, and it is at once converted into malleable iron.—"Examiner."

especially is entitled, then, to a prominent position, as of the greatest importance to our future advancement in commercial relations, political connections, and domestic happiness.

If we considered merely the extent and importance of our hardware manufactures, we should obtain a tolerable idea of the great value of iron ore to this country, but this forms scarcely a tithe of its consumption. For ship-building and architectural purposes it is now largely in demand; and for bridges, viaducts, houses, railways, gas and water pipes, &c., we are greatly indebted to iron.

Other nations, at the Great Exhibition (1851), showed us their strength in the raw material, as well as in the manufacture of iron and steel; but in our various descriptions of hardware, particularly cutlery and edge tools, machinery, implements, and railroad iron, we came off superior to most competitors; and the number of prize medals awarded to Great Britain and her Colonies, clearly proved that we maintain our ancient reputation for the excellence and abundance of our iron and steel.

Iron is revolutionising the world. The iron rails and the iron wires of the telegraph, stretched over the land or submerged in the water, have brought towns so near to each other, that a country has become but one vast city. And they are even bringing distant countries nearer to each other, and binding them into one common interest.

Deposits of iron are to be found in almost every country, and, from various sources, it appears incontrovertible that the ancients were acquainted with

its uses and properties to a very great extent, and could produce it nearly equal in quality to the iron of the present day.

Independently of sacred testimony to the fact that there were workers in metals at the early period of the world, 3,876 years before the commencement of the Christian era, we have continued mention of metallic productions both in the writings of poets and sages. We are not exactly aware at what period iron was discovered in this country, or when the art of working it was made known, but there appears to be little question that to the Romans we owe our first acquaintance with this metal, and the processes of its manufacture. They seem to have introduced iron foundries into the Silurian district, near Monmouth, and other places.

In Persia there are said to be very credible evidences of the mines near Tabreez having been worked from the remotest antiquity; large quarry-like excavations, thickly surrounded by immense tumuli of iron-sand and small pieces of iron ore, apparently thrown out in the course of the working, still existing, to mark the millions of feet of ironstone which have been here excavated. It is difficult to ascertain whether a knowledge of iron manufactures spread from Persia to Rome; or whether the latter empire received it from some other nation or discovered it by its own application, and, bringing it into a high state of perfection, subsequently introduced it into Britain. The departure of the Romans from this country, leaving it to internal distractions, was followed by a general suspension of the iron works. From the

time of the Conqueror to the death of John, iron and steel were both largely imported into England. In 1543 the iron manufacturers, on application, were protected by act of Parliament, which imposed duties on imported iron articles. To Holland we are indebted for the adaptation of iron, about the thirteenth century, to articles and productions of domestic usage, and its application to the more useful arts. In 1547 a person named Owen, in this country, first cast iron guns, and to the invention of England is owing the great advances made in iron manufacture by the blast furnace for the production of pig iron. The manufacture of the metal increased to the time of Elizabeth. About that period the wood in the vicinity of the works was falling short, being used as fuel, and in many places iron works were in consequence prohibited. In 1558, particularly, there was a great scarcity of fuel, and in the times of James I. and Charles I. a great number of furnaces were stopped. In 1635 it appears that royalty possessed three blast furnaces and two forges in the Forest of Dean, which shows the importance attached to iron manufacture at that period. Attempts were made in 1713 to use pit coal as fuel in them, but the result was not then satisfactory. Improvements having been subsequently made in machinery, it was again resorted to, and found to answer better; still there continued to be a decrease in the quantity produced. In 1740 there were only 59 foundries at work, producing 17,350 tons of iron. But when the use of the steam engine became general the improved effect began rapidly to show itself. The trade increased to 1830, when 112,647 tons of iron

were prepared. The success of the trade attracted the inquisitive eyes of the then Chancellor of the Exchequer, who endeavoured to put a tax on the produce. This was not done, however, but the duty on imported iron was, about 1826, fixed, on the motion of Mr. Huskisson, at 30*s*. per ton.

Probably no nation has greater advantages than ours with respect to this branch of production. Not only have we an abundant and almost inexhaustible supply of ironstone, coal, and limestone, &c., beneath the surface of our island, but we have them in such close proximity to each other that nature seems, by a geological deposition, to have determined this portion of the world as the spot, *par excellence*, on which the processes of iron manufacture should be experimentalised and perfected.

The principal sources of the iron of commerce are the oxides of that metal, which, mixed with variable quantities of siliceous and earthy matters, are abundantly met with in the United Kingdom.* The red

* This is the most generally distributed metal in existence. There is scarcely a thing in nature which does not contain the metal in some degree; even the human body contains iron in *considerable* quantity. The principal English iron works are in South Wales, and the ore is chiefly supplied to them from that neighbourhood. Staffordshire, Shropshire, Lancashire, and the most southern counties of Scotland also produce large quantities of iron ore, which are in nearly every case smelted upon the spot. The most plentiful iron ores are the carbonate, oxide and sulphuret, the latter being also largely used for making sulphuric acid. Some of the richest ores (oxide) will produce 80 per cent. of metallic iron. The specific gravity of the metal is 7·80. Next to gold, silver and

hematite, which also frequently receives the name of specular iron ore, is, in its various forms, a very important and valuable mineral for the purposes of the iron smelter; in its pure state it contains 69 per cent. of iron. Brown hematite is another very important ore of iron. Granular iron ore is, in many countries, one of the most plentiful and valuable ores of iron; and it is that which, in the oolitic form, supplies the greater number of French iron works. When washed, for the purpose of separating the lighter impurities, it yields an excellent material for the manufacture of iron. Another kind is that commonly known as magnetic iron ore, which contains the large proportion of 71½ per cent. of metal. No ore of iron is more universally diffused than this magnetic oxide, which is inferior to none for the manufacture of that metal. Nearly all the Swedish iron is prepared from this ore, which also occurs in great abundance in the Island of Elba, and in some of the States of America. The ores treated for

platinum, iron is the most ductile metal; its malleability is however much inferior. It is needless to mention the uses of metallic iron. It may be called the most useful metal in existence. It may be prevented from rusting by coating it with either tin or zinc—the latter process being termed galvanising. It is the only metal (except platinum) which can be "welded," and surpasses all other metals in tenacity. The sulphate of iron (commonly called "green copperas") is largely used for dyeing purposes; and a purified sulphate is used for photography. The oxide commonly called "colcothar," is a fine powder used by jewellers, &c., for polishing, and the citrate, tartrate, carbonate, iodide, and tincture of the sesquioxide, are used in medicine.—"The Metals in Every Day Use," by Johnson and Sons.

metallurgic purposes are always more or less impure, and usually yield from 24 to 35 per cent. of metallic iron.

There are two distinct qualities into which this metal is commonly divided, namely, pig iron and malleable or bar iron; the second being the result of an extension of the processes necessary for the production of the first kind. The first process is that of reducing the iron stone or ore, technically called "the mine," into a metallic state by means of fusion. This operation is conducted in a blast or smelting furnace. These furnaces cost about £3,000; blast engines, about £4,000; and heating apparatus, pipes, &c., about £2,000. Each furnace will produce nearly 200 tons of pig iron per week by hot blast, or 80 tons by cold; and by calcining the ore on the spot, fully 25 per cent. is saved in its carriage, and about two tons produce one ton of pig iron.

Steel is iron passed through a process called "cementation," the object of which is to impregnate it with carbon. Carbon exists more abundantly in charcoal than in any other fusible substance; and the smoke that goes up from the charcoal forge is carbon in a fluid state. Now, if you can manage to confine that smoke, and heat a piece of iron at the same time, it will become steel. Heating the iron opens its pores, so that the smoke or carbon can enter it. The conversion of the iron into steel is known by the blisters on the bars, and the process occupies from eight to ten days. The bars of steel, when taken from the furnace, are either sold as blistered steel, or drawn to a convenient size, and called tilted steel. German steel is

made out of this blistered steel by breaking the bars into short pieces and welding them together, drawing them down to a proper size for use.

A singular illustration of the ductility and tenacity of iron is the fact that it may be rolled so fine, by proper machinery, as to resemble writing paper; 7,040 square feet of what may be called leaf iron have been rolled from a hundredweight of metal. At the Prussian Industrial Exhibition, Count Renard, a large proprietor of iron works, exhibited sheet iron of this degree of tenacity; a bookbinder of Breslau made an album of it, the pages of which turn as flexibly as the fabric of linen rags. A similar book was shown at the Hyde Park Exhibition, 1851, from the Crown Iron Works of Mr. G. Downing, of Smethwick. The book was neatly bound in red morocco, and contained forty-four of these iron leaves, the whole being only the fifteenth of an inch thick.

A large manufacture is carried on of galvanised iron and tinned plates. Thin plates of iron dipped into molten tin, which completely covers the iron, are manufactured in South Wales and Staffordshire, to the extent of 900,000 boxes annually; their weight is 56,000 tons, valued at £1,500,000, and affording employment to 20,000 persons. [The make is now over 2,500,000 boxes of tin plates; about one-fourth of which are black or terne plates.]

The whole imports of metals in 1850 were but 17,000 tons. The Prussian manufacturers take our iron, which is better suited for casting. The cast iron productions of Berlin are justly held in repute, and her iron jewellery is also much esteemed. In the pro-

duction of iron, Austria stands foremost on the Continent, both as to the quantity and quality of its ores, and the antiquity of its mines. Its iron, and particularly its "Milan steel," as it is termed, are acknowledged to be of excellent temper; and, therefore, its scythes, sickles, and other steel articles, are held in high estimation, all over Europe and America. Sweden produces annually about 130,000 tons of iron, (in 1865, 235,000), of which she consumes less than half, the remainder being exported. We formerly took much of her ore for the manufacture of our fine steel, and about 4,000 tons of bar iron from Russia; but, owing to the improvements which have been made in this manufacture, we have become more independent of other countries, and the importation has decreased. The iron and ores of Norway are also exceedingly good; but not equal, for manufacturing purposes, to the Swedish.

The value of the iron and steel produced in France, in 1841, was about £5,600,000. In 1840, the production of iron was 447,000 tons, and in 1864 upwards of 1,200,000 tons by 430 furnaces.

Prussia, in 1854, produced 230,000, in 1860, 370,000, and in 1865, 772,000 tons of iron. From 75,000 to 100,000 tons of iron are annually raised in Nassau, of which the half is smelted there in the high furnaces worked by charcoal.

To show the wide range of our foreign supplies of iron, it may be incidentally stated here, that a cargo was recently imported from Canton, consisting of 1,526 bars and pigs, and 496 parcels of iron ore; and another vessel brought 100 tons of pig iron back from Shanghai.

Several of our colonies contain vast deposits of this valuable product. From the north shore of Lake Huron, to some distance below Quebec, large masses of iron ores have been found. Some of the beds range in thickness from 6 to 200 feet. Nova Scotia and New Brunswick also abound in iron; and Lower Canada is remarkably rich in this metal. Some masses of iron ore from Montreal, yielding 70 per cent. of pure metallic iron, were shown at the Exhibition of 1851. One specimen was taken out of a bed 48 feet in thickness, traced to the extent of a mile; and another from a bed 100 feet in thickness.

On the banks of Moose River, in Nova Scotia, a valuable bed of iron was discovered some years ago; and, in 1825, an association, consisting of 100 shareholders, was formed, and called "The Annapolis Iron Mining Company." Sufficient capital being raised, in the colony, to commence the smelting and manufacture of the ore, mineral lands, to the extent of 2,000 acres round the Annapolis basin, were purchased, and the mining rights of the company extended over a still greater area. Several thousand tons of ore were smelted, and castings made to a considerable amount. Bar iron was also produced, which, as well as the castings, proved to be of excellent quality. After expending, however, about £30,000, owing to some unfortunate disagreements among the members, the whole enterprise was abandoned, and the establishment sold.

Nova Scotia would receive great advantage from the manufacture of her own iron—which she now imports to the value of £20,000. The ores are very rich and

abundant round the Annapolis basin, and the Coquebid Mountains. In the neighbourhood of Moose River, the ore consists of a stratum, which outcrops at the surface of the earth, and is nine feet thick; the ore yields from 35 to 40 per cent. of cast metal.

At Nictau there is also a bed of ore 6½ feet thick, of superior quality; the quantity of carbonate of lime contained in it being also sufficient for its flux. There is a great want of smelting furnaces, where the metal may be extracted, in the British North American Colonies, for pig iron could very profitably be exported to the United States. There is a blast furnace at the village of Normandale, on Lake Erie, for smelting bog ore, which has been in operation since 1828. As much as 4,000 tons of ore have been found there within the space of a few acres; the ore averages 27 per cent. of iron. The townships of Marmora and Madoc, in Western Canada, are also noted for the excellency of their iron ore, which is said to yield 75 per cent. of iron, of the best quality, and so abundant as to be sufficient for the consumption of the whole of British North America. An iron mine is working at Fitzroy (Berrima), in New South Wales, the ore of which has the peculiar property of turning into pure steel when smelted. Very excellent specimens were sent from various parts of India, particularly the Tenasserim provinces.

Some few years ago, the mineral wealth of Spain was estimated at £38,600,000; but the Peninsula itself is falling off in its mineral produce, and it is chiefly her transatlantic possession of Cuba that is now valuable.

The United Kingdom, in this department of mineralogy, received at the first Exhibition thirteen

prize medals for iron, steel, &c., of which three were awarded to her foreign possessions, viz., to the East India Company, for its Wootz steel and specimens of iron manufactures—to Canada, for the quality of its iron—and to Nova Scotia, for its cast iron; the exhibitor, in this last instance, asserting the capacity of that province to produce steel and charcoal iron in quantities sufficient to supply the whole British Empire, and in quality equal to the best foreign articles, but at greatly reduced prices. The collection of specimens of our cutlery and steel was certainly very fine. The specimens of folded and twisted iron, in coils, shown by Mr. Ferrier, from Canada, were very creditable proofs of extra high temper, and superior workmanship. The prizes carried off by our miners and manufacturers were for iron and rod iron, tubes, and enamelled iron, and in Class 22, for quality of steel and iron, and fine iron-wire rope. Prize medals were also awarded in this class for a collection of maps and models of the mineral fields and workings, and a very varied and beautiful collection of the metals and their compounds, of the United Kingdom. Let us now see how other nations came off in the friendly contest.

The hardware and cutlery, &c., manufactured in the United States, amount in value to about 6,500,000 dollars. In 1840 there were 804 furnaces at work, producing 287,000 tons of cast iron; and about 800 forges turned out 198,000 tons of bar iron. In 1844, the value of the iron and manufactures of iron imported into the United States was but 5,250,000 dollars; while, in 1851, it had increased to

16,500,000 dollars. The railroad building, in that country, has added greatly to the consumption of iron. The chief increase in the imports of America took place soon after the tariff of 1846 came into operation. Prize medals were awarded to the United States for pig iron, boiler plates, and hammered bar iron, iron-wire rivets, &c., of fine quality; ores and bars of iron, and cast steel.*

* The number of hands employed in the primary production of iron in the United States is now roughly estimated at 140,000; 58,000 of whom work in rolling mills, 42,000 in preparing ore and fuel, 25,000 in preparing fuel for rolling-mills, 12,500 in blast-furnaces, and 2,500 at forges and bloomeries. Add the 800,000 engaged in manufacturing articles of iron, and we have a total of 940,000. The approximate value of the pig-iron manufactured in 1870 was 75,000,000 dollars. Adding to this the product of the rolling-mills and forges, the amount is 138,000,000 dollars. Adding again the value of articles manufactured of iron, and the value of the iron manufacture of the country for the year is 900,000,000 dollars. Of rails we produced in 1853 but 87,000 tons, and in 1869 the amount had risen to 580,000 tons. Of steel rails we laid in the latter year 50,000 tons, 15,000 tons of which were of domestic manufacture, and it is further estimated that the quantity of steel rails laid in 1870 will reach 150,000 tons. The annual importation of foreign rails has varied between 358,794 tons in 1853, and 10,186 tons in 1862, while in 1869 the amount again exceeded 300,000 tons, or more than half of the whole British export. We have enormous deposits of both coal and iron in close proximity, inviting the grandest development of iron industry the world has ever known. Figuratively speaking, we find our mineral resources gathered in a mighty elliptical bowl, the outer rim of which skirts the Atlantic coast to the Gulf of Mexico, and thence, crossing the Mississippi Valley, runs northward with the plains lying at the eastern base of the Rocky Mountains, and around by the great lakes to the

Belgium received eight prize medals; viz.,—for the fine quality of its cast iron, for moulding and refining; for sheet iron, prepared with wood; for six ingots of cast iron, for gun barrels; for sheet iron and sheet steel, for locks and hardware; and for the quality of bars of iron adapted for gun barrels, war arms, &c. In 1864, there were 52 blast furnaces in operation in Belgium, 153 iron manufactories, and 150 foundries.

Prussia particularly distinguished itself for the character and quality of its steel, having received the Council medal for rolled and forged cast steel, remark-

Atlantic coast again. The rim of this basin is filled with exhaustless stores of iron ore of every variety and of the best quality. From the Hudson river to the heart of Georgia the outcrop of magnetic ore extends one thousand miles in length, traversing seven States in its course. Parallel with this is the great limestone valley, which lies along the margin of the Appalachian coal-fields, in which lie buried masses of brown hematite, the abundance of which, especially in West Virginia and Virginia, staggers the imagination. We have here the splint, cannel, and bituminous coal of the Kanawha. Through the heart of this region, rich in iron ores, railroads will be built. Within the coal basin itself is a stratum of red fossiliferous iron ore, beginning in a thin seam in New York, and expanding in Alabama to a breadth of one hundred miles, with beds often fifteen feet in thickness. West of the Mississippi is traced through Arkansas and Missouri a range of red oxide of iron. Crossing the Mississippi this range culminates in ore-beds which have excited the wonder of the world. Along the Adironacks are beds of iron of the same character. In consequence of the strikes in the coal districts there has been a falling off in the iron production of our country this year (1870) of 250,000 tons, at the lowest estimate, and the price of pig-iron has advanced seven dollars per ton on American and five dollars per ton on Scottish.—"New York Evening Post."

able for its purity and toughness; and prize medals for samples of steel.

Russia carried off two of the prize medals for iron, one being awarded to the Messrs. Demidoff, and the other to one of the public iron works, for sheet, oxidised and boiler-plate iron. The old Russian Stobel iron has always maintained a high rank in the estimation of our manufacturers. The Russian collection of minerals, though not large, contained some very fine iron ores.

Switzerland obtained a medal for fine iron wire, suitable for making pattern cards.

Spain, Nassau, and Sweden and Norway, had also each a prize; the first for iron and steel from the Asturias; the second for its large and valuable collection of raw produce and metallurgy; and Sweden and Norway for the first-rate quality of its iron.

Austria came in for a liberal share of reward. She had prizes for ores, bar and pig iron, and the quality of her steel; for cast iron and steel; for hoop and cylindrical iron and plates of hard iron for cementing; a selection of Brescian steel; sheet and bar iron; hard and soft iron and several varieties of steel; rolled bar iron and iron wire, and sheet iron for tin plates.

Bavaria obtained a prize medal for iron and steel, and a Council medal for her iron of superior quality and manufacture, the prepared sheets being so thin, as to be called "iron paper."

Tuscany had a prize medal for her collection, illustrative of the mineral and metallurgic series.

France received three medals; one for steel, adapted for springs, and other purposes; another, for

the quality of its iron, known as Bigny iron, especially suited for edge-tools, ironmongery, machine, and carriage building; and the third, for iron tubes, suited for hollow iron furniture, as bedsteads, &c., &c.

From a recent publication, by Mr. Oechel Lawson, Secretary of the Association of Iron Producers in the Zollverein, we find that the consumption of iron per head, within the Customs' Union, had largely increased in the period between 1834 and 1850.

	Production. lbs.	Per head.	Import.	Export.	Consumption.	Per head.
1834-5	2,225,661	$10\frac{1}{3}$	524,466	287,391	2,492,736	$11\frac{1}{2}$
1836-8	3,042,462	$10\frac{7}{8}$	623,510	347,913	3,324,059	14
1839-41	3,406,653	$23\frac{7}{8}$	1,456,666	396,096	3,467,222	$18\frac{1}{4}$
1842-44	3,428,851	$13\frac{1}{4}$	3,548,673	351,761	6,629,763	$25\frac{1}{4}$
1845-47	4,085,567	$15\frac{1}{4}$	3,153,900	449,411	6,793,066	$25\frac{1}{10}$
1848-50	4,177,297	$14\frac{1}{3}$	2,124,245	351,507	4,950,035	$21\frac{3}{4}$

The imports within the last few years into the United Kingdom include the following:—

		Bar Iron.		Steel.
1848	tons	23,869	cwts.	348
1849	"	29,396	"	1,013
1850	"	34,066	"	49
1851	"	40,279	"	1,085

The exports in the same years of foreign and colonial iron, &c. were:—

		Bar Iron.		Steel.
1848	tons	3,432	cwts.	9,779
1849	"	5,036	"	24,151
1850	"	5,996	tons	649
1851	"	4,813	"	879

Value of our hardware and cutlery exported:—

1848	£1,860,150
1849	2,198,597
1850	2,641,432
1851	2,826,132
[1871	4,022,582]

The total value of our exports of iron and steel manufactures now (1851) is about £6,000,000 a year. Our shipments of mill-work and machinery exceeds another £1,000,000. Parliamentary returns show, that since the readjustment of the tariff, the importation of foreign manufactures, coming into competition with those of Sheffield and Birmingham, has not increased, but is rather declining. Whilst the exports of iron manufactured goods increased in 1850 by £1,000,000 over the previous year, the aggregate value of all foreign metallic manufactures consumed in these dominions, does not rival the transactions of a third-rate Birmingham merchant.

EXPORTS OF BRITISH PRODUCE AND MANUFACTURES OF IRON.

	1848	1849	1850	1851
Machinery and mill-work, steam engines, and parts of engines, declared value ..£	234,182	154,707	423,977	393,613
Of all other sorts ....£	583,474	554,364	618,189	771,320
Total ....£	817,656	709,071	1,042,166	1,164,933
Metals:—				
Pig iron ....Tons.	175.650	162,539	141,973	201,062
Bar, bolt, and rod .... "	338,688	398,007	469,434	539,877
Wire .... "	1,913	3,399	4,034	4,603
Cast.................. "	19,371	16,472	21,093	24,137
Wrought of all sorts .. "	83,606	121,935	136,296	139,276
Steel, unwrought .... "	6,913	8,133	10,593	11,894
Total......Tons	626,141	710,485	783,423	920,849

The aggregate value of the products of iron we ship annually will be seen by the annexed statement, and the increase has been progressive.

The declared value of the British iron and steel and their manufactures exported was in :—

	1848.	1849.	1850.	1851.
Iron and Steel	4,777,965	4,967,643	5,350,056	5,830,370
Machinery and mill-work ..	817,656	709,071	1,042,166	1,168,611
Total	£5.595.621	5,676,714	6,992,222	6,998,981

The entire quantity of pig iron made in 1750 was below 30,000 tons. It may now be estimated at 2,500,000 tons, a progressive increase of 100,000 tons per annum. The exports of all kinds from the United Kingdom during the past four years have been as follows—1848, 657,005 tons; 1849, 729,164 tons; 1850, 808,262 tons; and 1851, about 913,655 tons; but during the same period there has been a falling off, as compared with the two or three previous years, in the home demand, an inevitable consequence of the near approach to completion of our internal lines of railway, extending at the present moment over 7,000 miles.

The progress of the iron manufacture in this country has been astonishing. The quantity of iron made in Great Britain in different years was :—

In 1740			17,350
„ 1750			22,000
„ 1788	by	85 furnaces	68,000
„ 1796	„	121 „	125,000
„ 1806	„	169 „	250,000
„ 1820	„	— „	400,000
„ 1827	„	284 „	690,000
„ 1849			2,000,000
„ 1851			2,500,000

The production by different districts in 1827 was :—

	Furnaces.	Tons.
Staffordshire	95	216,000
Shropshire	31	78,000
South Wales	90	272,000
North Wales	12	24,000
Yorkshire	24	43,000
Derbyshire	14	20,500
All Scotland	18	36,500
Total	284	690,000

The annual out-put per furnace was in :—

		Tons.
1750	Average production per furnace	294
1796	....	1,033
1827	....	2,429
1840	....	3,473
1849	....	6,106

In 1830, Great Britain produced, by 376 furnaces, 677,417 tons; in 1840, by 402 furnaces, nearly 1,400,000 tons, as follows :—

	Furnaces.		Tons.
South Wales	132	....	505,000
Staffordshire	123	....	427,650
Shropshire	24	....	82,750
Yorkshire	25	....	56,000
Derbyshire..............	13	....	31,000
North Wales	12	....	26,500
Forest of Dean	4	....	15,500
Northumberland	5	....	11,000
All Scotland	64	....	241,000
Total	402	....	1,396,400

By 162 hot blast furnaces	.... tons	625,000
„ 240 cold blast „	.... „	771,400
402		1,396,400

The importation of iron at the beginning of this century amounted to about 40,000 tons annually, and the quantity made at home was under 150,000 tons. It was given in evidence by Sir John Guest, before the Committee of 1840, on import duties, that, in the year 1806, the quantity of iron made in the kingdom had increased to 258,000 tons; in 1823, the quantity produced was 452,000 tons; in 1825, it had reached

581,000 tons; in 1828, the quantity was 703,000 tons. At this point the manufacture remained stationary for a few years, but in 1831 it again began to advance; and, in 1835, the quantity made was estimated, on good grounds, at 1,000,000 tons. In the following year it was 1,200,000 tons; and, in 1840, was said to have reached 1,500,000 tons, including Ireland; while it is now 1,000,000 tons in excess of the latter total quantity.

The quantity of nearly 2,000,000 total tons in 1848 was thus made up:—

England	tons	735,800
Wales	„	722,800
Scotland	„	539,968
	Total	1,998,568

The near approach of Wales to England in produce is remarkable, and shows how rapidly the iron manufacture of South Wales must have been extending. In 1848, the total number of furnaces in blast was 623.

In 1851, the iron manufactured in this country amounted to 2,500,000 tons; of which 750,000 tons were made in South Wales; 775,000 tons in Scotland; 600,000 tons in South Staffordshire and Worcester, and 400,000 tons in other districts—one-third of the produce being employed in castings, and two-thirds in malleable manufactures. In order to obtain this extraordinary quantity, 7,000,000 tons of ore, 2,700,000 tons of limestone, and 13,000,000 tons of coal had to be extracted from the bowels of the earth; while, in addition to steam power, the labour of from 650,000 to 700,000 individuals, directly or indirectly employed,

was required. These statistics sufficiently illustrate the extensive scale upon which the manufacture is conducted; the immense demand for the article, both at home and abroad; and the value which Providence has stored in an unattractive mineral substance, scarcely distinguishable by the vulgar eye from an ordinary stone upon the roads. Nor ought it otherwise to be regarded than as a proof of wise and beautiful design, that the valuable ingredients are so combined with the worthless in the ore, and so deposited in nature as to tax the utmost ingenuity and industry of man to develope a useful product, for hereby the opportunity is afforded him, with high incentives to use it, actively to exercise his powers and improve them by cultivation. Four hundred specimens of British iron ore appeared in the Great Exhibition (1851). They are emphatically gems of the country, immensely more precious than the pearls and diamonds which formed the "wealth of Ormuz and of Ind," for they furnish occupation, with the means of subsistence, to hundreds of thousands of the population, while contributing to the social advance and foreign commerce of the kingdom, by the endless variety of important objects to which hardwares are applied.

The price of bar-iron at the close of the undermentioned years was as follows :—

	£	s.
1840	8	10
1841	6	10
1842	6	10
1843	5	0
1844	6	10

Best iron, angle iron, rail iron, sheet iron and hoop iron all exceed the above prices by from 5*s*. to 40*s*. per

ton. The highest price of pig iron since 1830 has been £6 15*s.* per ton, and the lowest about £2.*

* PRICES OF IRON IN STAFFORDSHIRE DURING THE LAST 20 YEARS.—The following statement as to the masters' selling prices of iron and rates for puddling during the last 20 years, is furnished by Mr. G. J. Barker, the Chairman of the South Staffordshire Ironmasters' Association :—

	January Quarter.		April Quarter.		July Quarter.		October Quarter.	
Year.	Bars.	Puddling.	Bars.	Puddling.	Bars.	Puddling.	Bars.	Puddling.
	£ s.	s. d.	£ s.	s. d.	£ s.	s. d.	£ s.	s. d.
1851	—	—	—	—	—	—	6 0	7 0
1852	6 0	7 0	6 0	7 0	6 0	7 0	7 0	8 6
1853	11 0	10 0	10 0	10 0	9 0	10 0	9 0	10 0
1854	10 0	10 0	10 0	10 0	11 0	10 0	11 0	10 0
1855	11 0	10 0	8 0	9 0	8 0	9 0	9 0	9 0
1856	9 0	9 0	9 0	9 0	9 0	9 0	9 0	9 0
1857	9 0	9 0	9 0	9 0	9 0	9 0	9 0	9 0
1858	8 0	8 0	8 0	8 0	8 0	8 0	7 10	8 0
1859	7 10	8 0	7 10	8 0	7 10	8 0	7 10	8 0
1860	7 10	8 0	7 10	8 0	7 10	8 0	7 10	8 0
1861	7 10	8 0	7 10	8 0	7 0	7 6	7 0	7 6
1862	7 0	7 6	7 0	7 6	7 0	7 6	7 0	7 6
1863	7 0	7 6	7 0	7 6	7 10	8 6	8 10	9 6
1864	9 10	10 6	9 10	10 6	9 10	10 6	9 10	10 6
1865	8 10	9 6	8 10	9 6	8 10	9 6	8 10	9 6
1866	8 10	9 6	8 10	9 6	8 10	9 6	8 10	9 6
1867	7 10	8 6	7 10	8 6	7 10	8 6	7 10	8 6
1868	7 10	8 6	7 0	7 6	7 0	7 6	7 0	7 6
1869	7 0	7 6	7 0	7 6	7 0	7 6	8 0	8 6
1870	8 0	8 6	8 0	8 6	8 0	8 6	8 0	8 6
1871	8 0	8 6	8 0	8 6	8 10	9 6	10 0	10 6

This statement makes it appear that the average price of iron for the last 20 years has been £8 2*s.*; and the rate for puddling 8*s.* 7*d.*

I may add, for comparison, the later value of the exports of iron :—

	1861.		1871.	
	Tons.	Value.	Tons.	Value.
		£		£
Machinery and Mill-work ..	—	4,213,670	—	5,942,357
Pig Iron	388,004	1,044,304	1,061,004	3,270,406
Bar, Angle, Bolt, and Rod ..	258,074	1,882,275	349,126	2,925,242
Railroad Iron	377,565	2,906,359	970,017	8,065,867
Wire	11,811	205,479	26,057	444,640
Hoop, Sheet, &c.	158,940	1,551,160	201,219	2,398,267
Tin Plates*	—	907,947	119,755	2,900,610
Wrought Iron, &c.	97,170	1,973,612	244,327	3,598,807
Old Iron	9,320	36,001	138,831	666,269
Steel	21,810	726,956	39,170	1,199,107
Manufactures of ditto	—	—	12,975	679,921
	1,322,694	11,234,763	3,162,481	32,091,493

* Quantities not specified in the official entries before 1862.

[The following tables show the progress of the Scotch Iron Trade, and the range of prices since the foregoing was written]:—

PIG IRON WORKS IN SCOTLAND.		Furnaces 28th Dec. 1871.		
Proprietors.	Works.	In blast.	Out of blast.	Total.
William Baird and Co.	Gartsherrie ...	12	4	16
Ditto	Eglinton	7	1	8
Ditto	Lugar	4	—	4
Ditto	Muirkirk	3	—	3
Ditto	Portland	3	3	6
Merry and Cunninghame	Glengarnock..	7	2	9
Ditto	Ardeer	4	1	5
Ditto	Carnbroe	6	—	6
Coltness Iron Co.	Coltness	12	—	12
Dalmellington Iron Co.........	Dalmellington	7	1	8
Monkland Iron and Steel Co.	Monkland......	8	1	9
Robert Addie and Sons.........	Langloan	7	1	8
Wilsons and Co.	Summerlee ...	7	1	8
James Dunlop and Co.	Clyde	5	1	6
Colin Dunlop and Co.	Quarter.........	4	0	4
William Dixon, Esq.	Govan	5	—	5
Ditto	Calder	6	2	8
Shotts Iron Co.	Shotts	3	1	4
Ditto	Castlehill	2	1	3
Wishaw Iron Co.	Wishaw	2	1	3
George Wilson and Co..........	Kinneil.........	3	1	4
Lochgelly Iron Co................	Lochgelly......	2	2	4
A. Christie and Co.	Lumphinnans.	1	1	2
Carron Iron Co.	Carron	3	1	4
James Russel and Son	Almond.........	2	1	3
C. and A. Christie	Gladsmuir ...	—	—	—
Ditto	Bridgeness ...	1	1	2
Total...............	....	126	28	154

On 31st December.	Furnaces in Blast.	Make.	Shipments and Home Consumption.	Stock.
		Tons.	Tons.	Tons.
1845	88	475,000	390,000	245,000
1846	98	570,000	666,000	149,000
1847	100	510,000	579,000	80,000
1848	103	580,000	562,000	98,000
1849	112	690,000	578,000	210,000
1850	105	595,000	535,000	270,000
1851	112	760,000	680,000	350,000
1852	113	775,000	675,000	450,000
1853	114	710,000	950,000	210,000
1854	117	770,000	860,000	120,000
1855	121	825,000	847,000	98,000
1856	128	832,000	842,000	88,000
1857	123	915,000	843,000	160,000
1858	132	945,000	810,000	295,000
1859	125	950,000	915,000	330,000
1860	131	1,000,000	903,000	427,000
1861	121	1,035,000	927,000	535,000
1862	125	1,080,000	970,000	645,000
1863	134	1,160,000	1,105,000	756,000
1864	134	1,160,000	1,156,000	760,000
1865	136	1,164,000	1,272,000	652,000
1866	98	994,000	1,136,000	510,000
1867	112	1,031,000	1,068,000	473,000
1868	121	1,068,000	973,000	568,000
1869	129	1,150,000	1,098,000	620,000
1870	125	1,206,000	1,161,000	665,000
1871	126	1,160,000	1,335,000	490,000

Price of Bars, December, 1871, £9 10*s*. @ £10 per Ton ; Plates, £11 10*s*. @ £12 ; Rails, £8 @ £8 10*s*. ; Railway Chairs, £4 5*s*. @ £5 ; Cast Iron Pipes, £5 5*s*. @ £6.

NET CASH AVERAGE PRICE OF MIXED NUMBERS PER TON, DELIVERED F. O. B. IN THE CLYDE.

	1845	1846	1847	1848	1849	1850	1851	1852	1853	1854	1855	1856	1857	1858	1859	1860	1861	1862
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
January	65 0	80 6	74 0	48 6	46 0	49 10	43 6	36 6	66 6	76 2	66 10	76 3	73 6	54 7	53 6	57 7	49 1	48 7
February ...	74 0	77 6	73 6	49 6	51 0	47 5	43 0	36 3	54 10	78 0	61 2	69 10	73 9	56 8	51 11	60 0	48 9	49 1
March......	105 0	71 0	72 0	44 6	49 0	44 4	41 8	36 5	52 11	77 8	57 10	68 4	75 5	57 1	52 0	58 0	47 6	49 6
April	107 6	65 0	71 0	42 0	47 6	43 0	41 4	36 0	52 8	79 5	60 0	72 11	75 0	53 3	51 8	53 11	48 1	52 9
May........	88 0	69 6	66 0	44 0	43 6	45 0	40 1	38 1	50 10	85 2	67 6	76 2	76 9	54 3	48 4	51 9	48 0	53 5
June........	65 0	68 0	65 0	42 6	44 0	45 6	39 5	40 0	52 9	88 8	75 8	75 3	77 4	52 6	48 0	50 8	49 6	52 7
July........	65 0	71 0	69 0	45 0	44 6	44 6	38 9	44 6	55 1	84 11	73 10	72 9	73 4	58 0	51 8	52 2	50 10	51 5
August	67 6	74 0	68 0	45 3	45 0	43 8	38 1	45 0	64 1	83 5	78 0	73 0	70 0	55 1	52 10	51 11	51 1	54 6
September ..	82 0	74 0	67 0	45 0	42 9	42 6	39 0	48 0	63 6	82 7	81 0	71 6	67 8	54 4	51 9	51 8	51 0	56 8
October	90 0	70 6	60 0	42 6	42 3	42 6	39 3	56 6	66 6	81 7	77 0	68 5	62 3	54 4	51 8	52 0	49 8	56 1
November...	77 6	69 6	51 6	41 6	44 4	43 0	39 3	58 0	78 2	71 9	76 6	71 3	53 8	53 8	52 4	52 5	49 3	56 2
December....	76 0	72 6	47 0	42 3	46 8	43 6	38 0	69 9	78 10	66 10	76 10	72 6	51 3	54 6	56 5	51 0	48 4	54 5
Average of the years ..	80 3	67 3	65 4	44 4	45 6	44 7	40 1	45 5	61 5	79 9	71 0	72 4	69 2	54 5	51 10	58 6	49·3	52 10
Aver. price of Bar Iron in	£9 10/	9 15/	8 5/	5 0/	5 17/6	5 9/	5 7/6	10 10/	9 7/6	9 15/	8 15/	8 17/6	8 16/6	7 10/	7 7/6	7 7/6	7 0/	6 12/6

Price of Pig Iron in 1810, £9 5s.; 1815. £7 15s.; 1820, £7; 1825, £11; 1830, £5; 1835, £4 15s.; 1840, £3 15s.
Production in 1788, 1,500 Tons; 1805, £9,000 Tons; 1820, 20,000 Tons 1825, 29,000 Tons; 1839, 197,000 Tons.

NET CASH AVERAGE PRICE, &c. (*Continued.*)

	1863	1864	1865	1866	1867	1868	1869	1870	1871
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
January ...	54 6	64 10	49 8	66 4	54 4	52 2	55 1	56 4	51 6
February ..	54 0	60 7	50 4	71 1	53 9	52 5	55 1	54 8	52 3
March......	52 5	57 9	50 9	77 2	52 6	52 10	53 2	54 3	53 7
April	50 9	59 2	53 9	78 2	51 11	52 3	52 9	57 2	55 1
May........	50 8	59 2	54 0	57 0	53 3	52 2	51 4	57 5	56 8
June.......	51 5	57 8	54 9	53 10	53 6	52 1	50 9	60 3	57 0
July........	53 10	58 6	54 7	52 10	52 11	52 8	50 11	55 1	59 0
August	54 0	58 2	54 9	52 4	53 5	52 9	52 2	51 3	62 0
September..	57 8	58 3	57 5	54 6	54 3	53 8	53 0	51 7	60 7
October	61 3	51 10	57 9	54 2	54 11	53 0	53 1	51 4	61 8
November..	62 6	51 0	58 0	53 5	54 1	53 5	54 6	51 1	67 9
December ..	65 7	50 2	61 9	54 4	52 8	58 7	57 0	51 3	70 0
Average of the years..	55 9	57 3	54 9	60 6	53 6	52 9	53 3	54 4	58 11
Aver. price of Bar Iron in	7 7/6	8 12/	7 15/	7 15/	7 2/6	6 15/	6 15/	7 15/	8 0/

We are on the brink of a revolution in this, one of the leading manufacturing industries of the country, by the introduction of Danks' rotary puddling furnace, which has been working successfully in America. The problem involved is a successful application of a mechanical process for the puddling of iron, which has so long engaged the attention of iron manufacturers, and would appear to be satisfactorily solved at last. A commission sent over to America by the Iron and Steel Institute, to enquire into the working of this system, has reported favourably on it as a success. It is impossible to over-estimate the changes which the general adoption of this invention may produce in the iron trade. For years and years there

has been the greatest difficulty in obtaining good puddlers. As is well known, the work is very severe and trying, even to the strongest of men, and the trade has of late had more and more reason to regret the paucity of skilled and able-bodied workmen. The new process is reported to be very perfect, better results in many respects being obtained than by ordinary hand puddling. Mr. Frederick A. Paget, C.E., in a paper recently read before the Society of Arts, stated—"There are more than 7,700 puddling furnaces erected in Great Britain. As each furnace costs about £130, the whole number represents an invested capital of more than £1,000,000 sterling. Supposing that only 6,500 of these are actually at work, and each turning out only 700 tons per annum, this would mean an annual production of more than 4,500,000 tons of puddled bar. At the present average price of £7 10*s.*, this represents a money value of nearly £34,000,000 sterling. At each of these furnaces two puddlers and two underhands or assistants are employed; thus making up an army of 26,000 men at work, for twelve hours daily, at the most laborious and arduous occupation in the whole range of manufacturing industry. For each ton of puddled bar at the very least an equal weight of coal is consumed. This amount is notoriously exceeded in almost every puddling furnace, except Mr. Siemens', by more than 25 per cent. We may, therefore, safely assume that the total weight of fuel consumed is at least equal to that of the iron produced, or 4,500,000 tons of coal.

Now if, without in any way altering the mode of

firing of these furnaces, we could, say by any mechanical aid, accelerate the puddling process by only 25 per cent.—that is to say, if the 4,500,000 tons of puddled bar could be produced in nine months instead of twelve, one quarter of the 4,500,000 tons of coal would be saved. At the present price of coal of £1 per ton, this would amount to a saving of £1,137,500, the puddlers themselves being also allowed to earn in the nine months the same amount they would otherwise make unaided in twelve, and no regard being had to other advantages to the masters and men."*

* At the annual meeting of the Iron and Steel Institute, held in London, in March, 1872, under the presidency of Mr. Henry Bessemer, further supplementary reports were read by Mr. J. A. Jones and Mr. Lester, two of the commissioners who had been sent to the United States. The former did not confine himself entirely to the results obtained at the Cincinnati works, but went on to show what Danks' machine will probably do in the future. Two plants were taken. On the one hand a works equal to producing 600 tons of puddled bars per week, with 50 puddling furnaces, had its cost put down, on a basis of 50*s.* per ton for pig iron, at £33,000; on the other hand, the cost of a Danks' plant, having precisely the same object in view, was set at £34,000, Mr. Jones adding that it is thought that twelve of Danks' furnaces will puddle as much iron in a given time as fifty ordinary furnaces, and that no fewer than ten heats, if not more, of 10-cwt. charges, are expected in twelve hours. Two estimates were also given of the relative cost in production between the ordinary and Danks' systems, the cost of puddled bars in the Cleveland district being put at £4 11*s.* 2*d.* per ton; that of the same from the Danks' furnaces being expected to be not more than £4. 0*s.* 6*d.*, giving a margin of 10*s.* 8*d.* per ton. Reference was then made to the remarkable yield procured by this furnace; how it reduces the fettling in place of melting

THE IRON INDUSTRY OF GREAT BRITAIN.*

THE Great Exhibition of 1851 did much good by stimulating the foreign demand for our Iron Manufactures. At the Paris Exhibition, in 1855, we were not so well represented in this respect; but at the International Exhibition next year (1862), on

it out, being in that respect the most perfect machine that has ever appeared before the public. Mr. Lester in his report explained the practical method of charging and working the Danks' furnace, and expressed the opinion that the puddling was better done than by hand labour. The operation was so much better for the men, that puddlers may be engaged upon it until fifty or sixty years of age. The manufacture was easily learnt, and the process decidedly a success. It is stated that an agreement has been entered into between Mr. Danks, the inventor of the new puddling machine, and a combination of iron manufacturers representing the different districts, whereby the latter undertake to have 200 furnaces on his plan put up within six months, and in consideration of his permission to do so, to pay him £50,000 at that time, whether the furnaces are in operation or not. In most cases this will represent an extension of the puddling power, seeing that the general body of the firms are not going to remove their old hand-puddling furnaces, and this will be equal to an additional make of 300,000 tons per annum. It is intended, on payment of a further sum, to erect 260 more; and this, with the 40 before arranged for, will make something like 500 furnaces added to the producing power of the country in a year or two. This is such a revolution as has never before occurred in the history of this branch of industry, and the more is it to be wondered at when it is remembered that, till July, 1871, it was thought that hand-puddling must for ever continue, every machine to do away with it having, before that, entirely failed.

* Published in the "Mining Journal," October 2, 1861.

our own ground, judging from official advices and private reports, Great Britain will be well represented in every department illustrating the raw material and its products. On the Continent we have little to fear in the way of competition, and the civil disturbances in the American Republic will materially retard the progress of their iron industry.

In 1850 the quantity of iron produced was about 2,380,000 tons; last year the make reached 3,500,000 tons. The value of the enormous quantity of pig iron produced in 1860, estimated at 50*s.* per ton, would give as the proceeds of the rough iron smelted in that year a sum of £8,750,000. The value of the material after the further application of skill and labour is, of course, very considerably increased. An estimate of the value of the manufactured iron may be obtained from the exports as shown in the Board of Trade Returns. Thus, in 1860, the exports of iron and steel, cast and wrought, of all descriptions, exclusive of tinned plates, &c., amounted in quantity to 1,441,067 tons, of the value of £12,158,355, being at the rate of upwards of £8 8*s.* per ton—in previous years it averaged about £9 per ton. If we estimate the whole of the iron manufactured in this country at the latter rate, it would give as the total value of the iron manufacture of the kingdom £31,500,000. This, however, does not include machinery and mill-work, and the finer portions of the manufacture involved in the production of hardware and cutlery, the collective exports of which alone amounted, last year (1860), to £7,597,386 (exclusive of that employed at home, and the large manufacture of rifles, &c.). It will probably,

therefore, be a fair approximation to estimate the entire value of the British iron manufacture at a sum of £40,000,000.

The declared value of the exports of British iron and iron manufactures has risen from £8,594,961 in 1851 to £21,254,422 in 1860. An industry which in its export branch alone has made such an advance in ten years despite casual difficulties must, with the incidental advantages of new markets, reduced foreign tariffs, stimulated demands, and new and important uses for the metal, go on steadily progressing, and give active and remunerative employment to capital and labour.

Of the entire quantity of iron made in Europe and America, Great Britain manufactures fully one-half; the United States about 1,000,000 tons; France, 700,000; Russia, about the same; Austria, 600,000; the Zollverein States, 400,000; and Belgium, 250,000 tons; the Northern States of Sweden, Norway, and Denmark, about 200,000 tons together; and Spain and Italy, about 100,000 tons. The rest of the world furnishes too little to be worth notice. France does not produce enough for its own consumption, and now draws largely from our furnaces; and we also send many thousands of tons yearly to Germany, Holland, Italy, and the Peninsula.

One of the great features of the present age is the triumph of Practical Science and the binding of lifeless matter into the service of man. Iron is every year made more and more to do the work of flesh and blood, and that, too, not merely in the rude department of physical force, but in tasks which require the

skill of practised workmen. One species of machinery has been invented after another to abridge human labour, and to such an extent has this been done amongst ourselves that Great Britain, with its comparatively small population of 26,000,000, contains a greater amount of dynamical resources than probably any other country in the world.* The employment of

* When Coal was first an object of commerce it was transported on the backs of men from the pit's mouth to the sea coast. A man in this way might carry a load of half a hundredweight, but after a time a pack-horse was substituted for the man, and carried about three hundredweight. As Science progressed, the pack-horse was attached to the wheel cart, into which its load was put, and it pulled along sixteen hundredweight. Then, as industry progressed, tramroads were laid down between the pit and the coast, and the same horse, drawing a waggon, carried forty hundredweight. Finally came the great triumph of Science, when coal was employed to pull itself. The smoking, snorting iron horse, fed with coal and water, drags along the railroad two hundred tons. The conversion of coal into force which produces this great result, is, in point of cost, scarcely greater than that of the human beast of burden, or the pack-horse originally used for a scant result; and yet our engines are so imperfect that they only use one-tenth and waste nine-tenths of the available force in coal. The importance of the transformation may be better understood if you view the force of coal as expressed in men's power; just as we do in speaking of an engine as having so many horse power. If human force were alone used in this country, the sum of production must be limited by the number of inhabitants. In such a case the United Kingdom could not produce more than the product of the labour of its thirty millions of inhabitants of all ages. But the coal excavated annually in this country represents in actual attainable work almost exactly the sum of the force of the whole population of the globe, viewed as adults. So that the use of a natural

steam power has become so general throughout the kingdom that the number of steam engines in use in factories, on farms, and on railways, besides marine engines, is very considerable. In agriculture alone there are about 30,000 steam engines employed; the locomotives on our railway lines must number fully 6,000. Ten years ago there were estimated to be 16,000 stationary engines in the kingdom working mines, iron works and rolling mills, factories, flour mills, and various other manufactories; and with the industrial progress and extended foreign commerce of the country these have, of course, greatly increased. The motive power in the various textile factories of the kingdom was returned in 1856 at 137,711 horse power.

If we glance at steam vessels, the greater part of which are constructed of iron, we find that while on January 1st, 1851, the number of merchant steamers registered in the United Kingdom was 1,181, of 167,398 nett tonnage; on January 1st, 1861, the number had risen to 1,863, of 429,474 tonnage, exclusive of engine room. The effective horse-power of these is nearly 200,000 horses, and of this number upwards of 1,000 are built of iron. On the average of some years past, 200 steamers have been built and registered annually, besides many built specially for, and others sold to, foreigners. In the

force, in substitution of human power, augments vastly the productive resources of our small insular kingdom, and enables it not only to supply its own wants, but also to export to other countries its superfluity of production.—*Sir W. Armstrong.*

British Royal Navy there are now nearly 500 steam vessels, with about 150,000 horse power. The demands for iron for various uses at home and abroad are incessant and progressive. The number of miles of railway open in the United Kingdom exceeds 10,300 miles, and about 1,000 miles more are in course of construction. At least 3,000,000 tons of iron must have been used for these, and about 300,000 tons are annually required to keep them in repair. In our own Colonial possessions many lines are open, and others are in course of construction in Canada, India, South Africa, Australia, and the West Indies. In British India there will be nearly 2,000 miles open by the close of this year. In the United States there are about 28,000 miles of railway in operation. The rails, locomotives, stations, &c., of all these have consumed large quantities of iron. But there are hundreds of other extensive demands for iron. Huge anchors and chain cables are forged for leviathan ships, boiler plates have been made weighing one or two tons each, engine shafts of several tons, and cylinders up to 30 tons. Thousands of miles of electric wire and submarine cables are manufactured; tons of gas and water pipes are required at home, and shipped to every country and colony in the world. Iron bridges, tunnels, and viaducts span rivers, straits, or valleys, while iron dwellings, churches, and stores spring up in many directions. The demand for iron for shipbuilding, now that timber is becoming scarce, is greater than ever, both for the Royal Navy and mercantile marine.

A writer in the "Westminster Review," commenting

upon the Exhibition of 1851, thus spoke of a want which in most respects has been since supplied in the Great Eastern, a vessel which, notwithstanding all its past commercial casualties, may yet become a profitable speculation, and a feeder to the International Exhibition of 1862 :—

"Amid the models of vessels of all kinds we miss the practicable future—an iron ocean steamer, of ten or more thousand tons burthen, that shall still the heave of the waves afloat, as Plymouth Breakwater does on shore, and make the salt water the home of the Celt, without the heaving of his diaphragm in sea sickness; built of iron scantlings that shall bear a proportion to its size, rolled and fashioned by the dock side from the iron ingots by tools of giants, one sole heat sufficing to give it permanent form in the structure; built in sufficient compartments that shall defy leakage, though riddled as a colander; strong as Atlas to crush the rocks on which it may strike; swift as the salt-sea shark, with artist fins of metal work; laughing to scorn, like an ocean monarch, the irate cachalot that sometimes sinks the whaler in his fury; mocking at fire, like the iron horse of the rail; coated with rust-proof enamel; furnished with apparatus to change the salt wave into the mountain water; provided with iron cellars, to arrest the decomposition of fresh food for all time; furnished with hermetic gardens, with machine music, with books, paintings, and sculpture—with warmth and coolness at will, with armed strength to bid all ocean-rovers defiance—an ocean palace, moving over the face of the waters whithersoever its ruler listeth. It were a

worthy source of pride to be the builder of a craft like unto this."

Though we have no data to calculate the increase in the consumption of iron at home for various purposes, in the improvement and extension of mills, bridges, and other erections, we know that every year sees a vast quantity used up for beams and girders, pillars, lighthouses, agricultural implements, conservatories, wire-rope, and other minor purposes.

In the words of Mr. Warington W. Smyth, "Enriched in a wonderful degree by Nature, and favoured by the energy of her people, Great Britain maintains, as she has done since the end of the last century, a surpassing pre-eminence in the production of the ordinary classes of iron, which, after all, form the great bulk of what is demanded by Commerce. In magnitude of production and lowness of price we are at present unrivalled, and the task for the ironmaster in future will be to endeavour, by scientific treatment of his subject, to produce a superior article at the same or at a less expense."

While on the subject of iron we cannot conclude without some incidental notice of the iron ores of our Colonies. Although not very largely utilised yet, iron ore abounds in very many of the British Possessions. The Acadian iron ore of Nova Scotia is well known, so is the magnetic, specular, and bog iron ore from Canada. Iron ores are met with in many parts of British India. At the different local Exhibitions at Madras, iron from various parts of Southern India was shown. Thus iron ores exist and are worked in the native forges of Masulipatam; iron sand is met with in the beds of rivers and gullies in Mysore, and

native iron and iron ores are also found; there are iron ores in Pondicherry, from which pig iron and rails are made; iron ores and metallic iron were shown from Madura by the Rajah of Poodoocottah ; and ironstone was sent from Goondalapully and Toomaragod, in Guntoor; iron ore is found in many districts of Travancore, but only in that of Shencottah is there any extensive smelting conducted. About 250 tons of iron bloom is annually manufactured in the several districts of Travancore. This manufacture, if scientifically conducted and properly managed, could, it is stated, be improved so as to meet the wants of the country. This is not the case at present, for a better and cheaper article is imported. At the Paris Exhibition iron ores from various parts of India, from Chota-Nagpore, and from the Himalayas, and Wootz steel from different localities, were shown. The iron sand of Taranaki, New Zealand, has recently attracted much notice at home, from the excellent cutlery made from it, and a neglected abundant product has now come into commercial demand.

In various parts of Australia iron ores are met with. In Tasmania clay ironstone is found in nodules, alternating with coal and shale, at the Douglas River, on the east coast of the island. Red hematite, an iron ore yielding 90 per cent. of metal, is found on the Tamar River. Anglo-Saxon industry, enterprise, and capital, will, no doubt, ere long, develope their capabilities. There is no question whatever, that several of the Australian colonies possess iron ores of great richness. It is estimated that 2½ tons of the ironstone of Tasmania will yield 1 ton of good pig iron. But with that fact demonstrated, the practical question will yet

remain undetermined—whether the island can send its iron into the market of India, of the neighbouring colonies, or of any other part of the world where there is a demand for it, and sell it there on terms that will defray the cost of production, and leave a profit over.

Good iron ore is not a scarce article in England, where labour and fuel are much cheaper than they are at the antipodes; and in the colossal smelting works of South Wales and Staffordshire an economy of production has been reached which is only attainable where enterprise is carried on on a gigantic scale. Unless Tasmania can smelt its iron, and turn it into forms fit for practical uses at a less cost than is done in England, or else produce a material very much superior in quality, so as to command a special market at a high price, it can have no hope of superseding in any direction the use of British iron. Even in supplying the neighbouring colonies, they would have to pay as much for the freight of the iron to Melbourne or Adelaide as it costs to bring the metal from England. Unless experiments prove that the ore will yield a metal of surpassing excellence, there is very little promise of success in this respect for the colonists.

At Bendigo, in Victoria, iron ore has been met with, and late accounts state that some 6 or 8 cwts. of it were smelted at Messrs. Langland's foundry, Melbourne, which yielded iron of a very fine quality. The assays are expected to give from 65 to 70 per cent. of pure metal.

It was stated some years ago that iron ore in strata was to be found in the colony of Western Australia to any extent, and experiments were made which showed

that it yielded a larger per centage of metal than the average of ores in England. In the neighbourhood of the Williams' iron ore is met with in small cubical and, in other instances, in spherical masses, black, and very hard. In several other parts of the Colony iron ore is found lying on the surface.

In New South Wales the Fitzroy Iron Mine is situated at Mittagong, on the Goulburn road, seventy-five miles from Sydney, at an elevation of 2,053 feet above the sea, from which it is distant, at Wollongong only twenty-one miles. The actual extent of the mine is supposed to be about a hundred acres. This iron field offers to the ordinary observer some remarkable features. The ore lies scattered on a surface of gentle inclination in huge blocks, the intervals being in many places occupied by a rich red oxide. The investigations of Mr. Keene, the Government mineralogical surveyor in the vicinity, having satisfied him that the iron ore had been protruded through a coal field, this mineral was searched for successfully a short distance beyond the edge of the iron field, and found in seams from 3 to 3½ feet in thickness. The iron produced from this ore possesses remarkable qualities; it requires no flux in smelting, and the metal when smelted is made perfectly malleable with very little labour. The specimens at the Paris Exhibition in 1855 were calculated to show the facility with which it can be applied to work requiring the finest descriptions of iron. It appears to exist in quantities practically inexhaustible, sinkings to the depth of twenty-eight feet having been made, the whole way through an unbroken mass of ore. Formations of similar character abound in many parts of the Colony.

THE PROGRESS OF OUR MINERAL INDUSTRIES.*

THE trade, commerce, and material progress of Great Britain are mainly founded upon her mineral and metallic wealth, and the vast industries and manufactures which they give rise to. Steady and continuous as has been the advance of mining and metallurgic operations in the kingdom, the strides made in the last ten years have been gigantic, and the results springing therefrom highly beneficial, whether regarded in an individual or national point of view. Let us merely examine, in the first instance, our foreign commerce in Minerals and Metals in 1850 and 1860, (apart from the larger question of the entire home production), and we shall find immense expansion. We will take first the imports.

In 1850, we imported 665,269 cwts. of brimstone or sulphur—no copper ores; 34,066 tons of iron in bars—no steel; 11,876 tons of lead, pig and sheet; 355,079 lbs. of quicksilver; 18,626 tons of zinc; and 33,711 cwts. of tin. We take the year immediately preceding the Great Exhibition of 1851, as affording a correct index of the position of our trade at that time. And now what do the import tables of last year show us, even with respect to these few items?—an increase in all instances of 75 to 100 per cent. In 1860, we imported 1,007,503 cwts. of sulphur; 109,070 tons of copper ore, regulus, &c.; 54,061 tons of iron

* Published in the "Mining Journal," April 20th, 1861.

bars; 3,788 tons of steel; 22,171 tons of lead; 2,966,588 lbs. of quicksilver; 23,481 tons of zinc or spelter; and 58,220 cwts. of tin.

But it is in the value of our metallic exports that the greatest progress is shown; for, exclusive of our large demands for coal, iron, machinery and mill-work, hardware, &c., at home, the value of our exports has nearly doubled; and much of this increased trade is mainly owing to the opening up of fresh markets, new customers obtained through our national display in 1851, and to the modifications of adverse foreign tariffs since brought about by international congresses, &c. With the extension of steam ships and steam navigation, our export of coal has increased in the ten years from 3,351,880 tons to 7,348,328 tons, and this without trenching upon our increased home consumption. The following comparative figures show the declared value of British produce and manufactures, mineral and metallic, exported in the two periods :—

	1850.		1860.
Brass and Copper, wrought	£1,978,196	...	£3,001,992
Coals, &c.	1,284,224	...	3,321,539
Hardware and Cutlery ...	2,641,432	...	3,772,025
Iron and Steel	5,350,056	...	12,158,355
Lead and Shot	387,394	...	699,648
Machinery and Millwork	1,042,167	...	1,230,628
Salt	224,501	...	358,090
Tin, unwrought..............	124,798	...	363,469
Tin Plates, &c.	944,940	...	1,498,681
Total	£13,977,708		£26,404,427

That some benefits have accrued, in a national point of view at least, from the magnificent collection of

British mineral produce, metals, machinery, and manufactures shown in 1851, all will, we think, admit.

At the Paris Exhibition, in 1855, British mineral produce, as a whole, and mining operations generally, were very imperfectly represented, and this, we think, was bad policy. Although there were a few good collections, yet there were scarcely more than 50 exhibitors in all from the United Kingdom. The class of "Mines and Metallurgy" was divided into nine sections. Under the 1st, "General Statistics and Plans," there were two or three topographical and geological maps and sections shown, with some few statistics. Under the 2nd Section, "Modes of Working Mines," there were two models only of coal mines. Under Section 3, "Modes of Preparing Metals," nothing whatever was shown. Section 4, "Coals and Combustible Materials," contained fair representations of the fossil fuels which are so important an element in our manufacturing industry, our navigation, and our export trade. A collection of the various qualities of coal suitable for domestic purposes, steam generation, the production of gas, furnace use, and general manufacturing purposes; with samples of locomotive and foundry coke, patent coal, and patent fuel, was made at the instance of the Department of Science and Art, to which the various collieries, coal-owners, and patentees responded readily by small samples. In Section 5, "Iron," a very good collection of ores and metal was contributed by Messrs. Wm. Bird and Co. for the general iron trade, but in the next Section, "Other Common Metals," the articles shown were poor in the extreme, comprising only a few samples of

copper, lead, and white blende. Section 7, "Precious Metals," afforded more scope for exhibition from Great Britain, but there was only a collection by Mr. Sopwith, some silver-yielding ores, and a machine for crushing ore. Section 8, "Coins and Medals," was a sub-division out of place among raw materials, and belongs properly to another division. There were only two British exhibitors—Mr. B. Wyon and Messrs. Lincoln and Sons. The 9th and last Section embraced "Non-metallic Mineral Productions," and here there was a very paltry display of fine salt, potter's earth, sands, and clays. Looking at the large national outlay (£40,000) voted to render the collection creditable, certainly as regards the mineral industries, it was by no means such a representation as was calculated to raise us in the estimation of Continental countries.

Great Britain, then, the nation of metallic industry, *par excellence*, at Paris played a part insignificantly subordinate to several of the European countries. In the words of Mr. Warington Smyth, in his subsequent official report to the President of the Board of Trade—"A single glance at the 1st Class of the British part of the Exposition sufficed to show a marked difference from that of 1851. The gigantic masses of fossil fuel—the spring of our commercial greatness—were absent; those huge blocks of coal, in some cases illustrating only the peculiar cleavage and character of certain seams, in others, reconstructing at the surface the pile of successive layers worked in the depths of the earth, were so costly to the exhibitors in Hyde Park as to preclude, unless some special reason existed, their being thus extracted for a second occasion.

Still more was it observable that there was scarcely a trace of the bold rocks of metallic ore which, in 1851, represented with a sort of rude grandeur, although not always with scientific meaning, the varied and abundant mineral treasures which enrich our island. Nothing like the monster crystals of galena from Snailbeach and Laxey, nothing equal to the section of the Duke of Devonshire's lode at Grassington, nothing recalling the fine blocks of Cornish tin ore, caught the eye on the first entrance; and closer examination made it evident that, as regarded our raw materials, *Britain was most inadequately represented.*"

Now, the italics here are not ours, but those of Mr. Smyth, and if so competent and eminent an authority admits the discreditable fact, there can be no disputing it. If, then, we were not duly represented at the short distance across the Channel, let there, at least, be an effort made that we shall show well on our own ground, and not be distanced by foreigners, as far as regards minerals, metals, and machinery.

If we can read correctly the prevalent feeling current as to the matter in hand, it seems quite clear that the special department with which we are chiefly interested will be duly represented in 1862 by British contributors, both at home and in the Colonies. That we shall have a noble display of minerals and metals from the Colonies is quite clear, from the systematic way in which our Possessions are going to work. On the last occasion they had not fair play, or due notice for preparation. Everything was done in 1851 hurriedly and in confusion, with no experience to guide them. Now the matter has been more calmly and systematically

undertaken, without the necessity of agitation and explanations; now the Colonies, having had a clear year's notice, have been able to obtain large Colonial grants from their Legislatures, and to form competent local committees to carry out the arrangements of collection, transmission, &c. Moreover, the Royal Commissioners evidently contemplate some permanent trade museum hereafter; for in their recent circular letter to the Governors they invite exhibitors to furnish, when practicable, duplicate specimens, as, besides the aggregate collections, they wish to classify colonial raw produce, bringing all minerals, textile materials, and so on, into one general comparative view. Such an arrangement, although it has been much carped at, will greatly facilitate reference and comparison by those specially interested in particular products. Such persons may study closely and collectively a group of objects, noting locality, quality, price, and other details, without having to wander all over the huge building to pursue their investigations. This will in no way interfere with special and geographic collections, but is rather intended to supplement them by stimulating enquiry and the examination of finer samples in the particular complete collection.

The British Possessions of 1862 are very different both in character, population, and wealth, to what they were in 1851; several new and important colonies have been formed, including Victoria, Queensland, British Kaffraria, and British Columbia. The gold discoveries in Australia were only in their infancy in 1851, now they have become an established fact; while the gold-bearing districts of California have been supplemented by those of British Columbia.

The copper and malachite of South Australia and Western Africa are now articles of commerce, so is the antimony of Borneo. New sources of sulphur have been opened up, and new metals discovered. The practical researches of the chemist have largely developed the uses of minerals; while iron, as a constructive material for use on land or on sea, has added greatly to the industry of the nation, and supplied the wants which the deficiency of ship-building timber had created.

The taste for geological and mineral investigations has been greatly promoted in an educational point of view of late years; lectures by professors, evening classes, geological tours, cabinets and collections for schools and public institutions have been made, which have largely extended a knowledge of soils, strata, and minerals, and which cannot fail to be eminently useful to the rising generation, whether their future operations be carried on at home or abroad.

There are many incidental topics and suggestions that will arise out of the consideration of this great subject, connected more or less with mining and metallurgic operations. At Paris, in 1855, the Commissioners of Sewers of the Seine exhibited a subterranean atlas of Paris, intended as a guide for the operations of extensions, repairs, &c., which are continually going on underground in that capital. Now, such a plan prepared and shown by our Commissioners of Sewers and Board of Public Works would be of great utility in many points of view, for the public in general have no conception of the extent, direction, and ramification of the sewers of this great metropolis. It would guide

many building operations, and greatly facilitate collateral works carried on above and below ground. The geological and topographical surveys of England have also made great progress since 1851, and the public will be able to see from the labours of the officers of the School of Mines the important duties that have been slowly but assiduously prosecuted by that department in Jermyn-street, the Ordnance Survey, &c.

THE GLASS MANUFACTURE.*

The constructive purposes for which Glass is used are very numerous. The principal kinds are, of course, crown glass and German sheet glass—the best window glass; broad glass, or common window glass; plate glass, and rough plate for conservatories, skylights, and for floors; coloured glass, glass tiles and slates, and glass pipes.

Window glass is subdivided into three descriptions:—

1st. Crown glass, blown into the shape of large globes, and afterwards opened out into circular flat plates. 2nd. Sheet glass, blown into the shape of long cylinders, and afterwards opened out into square flat plates. 3rd. Plate glass, cast on large iron tables, used, in the rough state, for skylights and railway station and other roofs, and, when ground and polished, for shop-fronts, windows, mirrors, glazing prints, &c.

Mr. George Shaw, Professor of Chemistry in Queen's College, Birmingham, and Mr. Henry Chance, in lectures delivered before the Society of Arts, have each given very interesting details as to the manufacture of glass. The paper of the last-named gentleman, read on the 13th February, 1856, "On the Manufacture of Crown and Sheet Glass," was essentially practical. But neither of these gentlemen have favoured us with any facts or figures calculated to con-

* Published in the "Building News," in 1855.

vey a notion of the trade in window glass for the purposes of the builder, the shop-fitter, glass for the upholsterer, print-framer, &c. We purpose, therefore, placing, in a collected form, some scattered official and other data which may serve to show the extent and importance of the manufacture of glass for purposes in which the architect and builder are most interested.

Crown glass and German sheet are manufactured for windows, hothouse roofs, skylights, &c.

1,000,000 of square feet, weighing 400 tons, were used for glazing the Great Exhibition building in 1851, and a larger quantity for the Crystal Palace at Sydenham. Crown glass, being made in a circular form, called "tables," is generally packed in a narrow triangular-formed crate, containing 18 tables, divided=36 sides, weighing 2½ cwts.; but extra thick is in crates of 12 tables. German sheet glass is usually packed in small square boxes; and rough plate glass in strong heavy cases. The aggregate manufacture was about 12,000 tons in 1850, and the value £250,000.

The production of plate glass, polished, for windows and looking-glasses, and for cabinet furniture, was estimated by competent parties in 1850 at 1,750,000 superficial feet, weighing 2,300 tons, of the value of £260,000. This was exclusive of 400,000 feet—1,000 tons—of rough plate glass, worth £20,000 more. Flattened crown squares and crown squares are sold, cut to size, at per foot.

The weight of plate glass averages 3 lbs. per superficial foot polished, and 6 lbs. rough.

There are six companies concerned in the manufacture

of plate glass—three at St. Helen's in Lancashire, one at Birmingham, one at Newcastle, and one in London. These are the British Plate Glass Company at Riverhead, the Union Plate Glass Company, and the London and Manchester Company, at St. Helen's; the Birmingham Plate Glass Company; Swinburne and Co., South Shields; and the Thames Plate Glass Company at Blackwall. The aggregate make of these companies was 350,000 square yards—that of France being 380,000; of Germany, 120,000; and of Belgium, 100,000. Thus twelve companies or firms, with sixteen works, produce about 1,000,000 square yards of plate glass, of the value of £1,120,000. The average value of the square yard of polished glass may be taken at the present time at 22*s.* 6*d.* In the last twenty years the cost price has been reduced 60 per cent. which has largely developed production and consumption. To the British production must be added 70,000 superficial yards of rough glass and 400,000 yards of rolled plate glass.

About one-half of the quantity made in the provinces is despatched to London, for the supply of the metropolis and for distribution in the southern parts of the kingdom. The capital employed in the plate glass manufacture exceeds £1,000,000 sterling, giving employment to about 2,000 hands.

Stained glass of various colours is sold at per foot, in sheets and squares.

In a lecture by Mr. James Hartley, the extensive glass manufacturer, of the Bishopwearmouth Works, Sunderland, speaking of the progressive increase in the manufacture of crown and sheet glass, he stated

that in 1844, the last year of the duty, there was made by the fourteen companies then existing 6,700 tons of crown and sheet glass, paying £500,000 duty; there are now ten companies, working 40 furnaces, with 284 pots, making 35,500,000 feet, annually, equal to 15,000 tons, valued at £225,000, being an increase of considerably more than cent. per cent., and at a charge to the public of less than one-half of the former duty. In polished plate there are six companies, being the same as existed in 1837, and consequently their number has remained stationary since the repeal of the duty, but their production is estimated to have doubled. They now make 3,000,000 feet of polished plate annually, equal to 5,500 tons, valued at £450,000. Of Hartley's patent rough plate the quantity now manufactured annually is 2,240,000 feet, of 2 lbs. to the foot, valued at £30,000.

In Hartley and Co.'s glass tariff there are 7,329 figures, also 17 descriptions of glass, with 51 thicknesses. Messrs. Hartley's warehouse, or depôt, at Sunderland, for the complete produce of their great works, 270 feet long by 75 feet wide, is glazed over its whole extent with their patent rough plate, one-eighth of an inch thick, and weighing 2 lbs. to the foot, the kind now almost universally used for conservatory and railway station roofs, and which was supplied by Mr. Hartley to Messrs. Fox, Henderson and Co. for the latter purpose, in the instance of the immense roof erected at the Great Western Paddington Station—the first building so roofed after the Crystal Palace, in Hyde Park. Hungerford Market, and the new baths at Buxton, were also glazed with this material. The size of the squares is 76 inches by 20.

They amount to no less than 1,560 in number, equal to 16,400 superficial feet, and yet to no more than 14 tons in weight!—an extraordinary lightness, if we contrast it with the glass roofing of the Great Northern Railway Station in London, in which the plates are half an inch thick, and consequently enormously heavier. In equal areas, in fact, of roofing, the difference between this glass and the rough plate of Messrs. Hartley would be between 14 tons and 56 tons! It has been proved by the great tests of practice and experience that the thickness—one-eighth of an inch—is amply sufficient to resist the force of any casualty, while it is free from liability of self-breakage after glazing. Now, on the other hand, the half-inch thickness renders the plates extremely apt to fly across, as it is called, partly from their weight and rigidity, and partly from their unequal contraction and expansion under varying atmospheric temperature. Nor should it be forgotten that this extra and certainly superfluous cost of thicker glass involves of necessity greatly increased strength in every part of the building so roofed—a very serious consideration with both proprietors and architects.

The abolition of the excise duty on glass and of the assessed tax on windows gave a great impetus to the enlarged use of glass in buildings, and the number of windows in dwelling-houses; and the construction of green-houses to new buildings has been greatly extended.

The produce of the little kingdom of Belgium—the greatest glass-producing country in the world—is 50,000,000 feet of sheet glass annually, equal to 22,300 tons. Of this quantity 85 per cent. is exported.

6 per cent. comes to England, and they retain 15 per cent. for home consumption. The production and value of the principal kinds of glass exported from Belgium in 1865 were as follows :—

		Value, frs.
Window Glass, square metres	7,491,000 ...	9,712,000
Bottles and Phials, number...	9,945,000 ...	1,003,000
Plate Glass, square metres...	100,000 ...	2,700,000
Total		13,415,000

There are about fifty-four glass works, with 72 furnaces, in the different branches of manufacture, employing 6,764 workpeople. The aggregate value of the glass of all kinds made was 18,250,000 francs.

M. Bontemps, in his introduction to the French section on Glass, at the Paris Exhibition of 1867, states that the goods made involve eight separate processes of manufacture. 1. Crystal glass, with basis of lead for table services, lustres, candelabra; ornamental and fancy crystal glass, cut and plain, white and coloured, threaded, gilt and painted. 2. Fine and common table glass, articles for restaurants and cafés, mineral water bottles or syphons, retorts, and other chemical apparatus. 3. Glass for mirrors and windows, moulded glass for lighthouses and paving, rough glass, channelled and plain for glazing conservatories, &c. 4. Window glass, plain and coloured; cylinders, globes, and shades of various shapes, glass tiles. 5. Bottles for wine and mineral waters, bell glasses for gardeners, &c. 6. Flint and crown glass for optical purposes. 7. Enamel in block and in tubes, for jewellers, enamellers, &c. 8. Stained glass.

These products are chiefly manufactured in the

departments of the Nord, Aisne, the Seine, the Meurthe and the Moselle, the Rhone, the Loire, and the Allier. The raw materials of the glass manufacture principally comprise silica, which, in the shape of sand, forms one-half the bulk of flint glass and three-fifths of other kinds of glass; oxide of lead, which forms one-third part of the composition of crystal glass; carbonate of lime, which represents one-fifth of the composition of common glass, and sulphate and carbonate of soda, which also form a fifth of the composition. With the exception of the lead, these materials are all of home produce; the lead is derived from Belgium, England, and Spain.

The fusion is performed in crucibles, heated by coal or wood; but the substitution of the former for the latter fuel is becoming universal. The glass manufacture depends principally on the skill of the workmen—machinery plays but a secondary part. It is only in the case of plate glass that machinery is indispensable.

Glass making is carried on in houses provided with furnaces, glass-cutting, dressing, and polishing shops. The workmen generally work by the piece, and there are no middlemen employed. The glass houses employ few women, but the number of children engaged about the furnaces is nearly equal to that of the men. Paris is the chief market for flint, table, and plate glass, as well for home consumption as for exportation. Window glass is sold to wholesale dealers, who retail it to the glaziers. The bottle makers sell to the wine producers, bottlers of mineral waters, and wholesale dealers.

The annual production of flint glass has risen since 1862 from 9,000,000 to 11,000,000 or 12,000,000 francs. Ordinary table glass is extensively manufactured in France, and the importance of this trade is at least equal to that of flint glass. The production of plate glass is estimated at 350,000 to 400,000 square metres per annum, and the trade at 12,000,000 or 13,000,000 francs. The quantity of window glass produced may be set down as 5,000,000 to 6,000,000 square metres, of the value of 12,000,000 to 15,000,000 francs. The number of bottles is estimated at 100,000,000 to 110,000,000, of the value of 18,000,000 to 20,000,000 francs. The glass trade is increasing in all parts of the country, and it is probable that the glass stainers of France will speedily rival the skill of the old masters. Finally, the value of the whole industry reaches about 75,000,000 francs, one-third of which represents the salaries of 35,000 men, women, and children.*

* M. Bontemps, in "An Historical and Practical Treatise on Glass Making," recently published in Paris, gives the following statistics of the glass trade in France :—

	Value. Francs.		Weight of produce. Kilogrammes.
Window Glass ...	12,500,000	...	31,000,000
Looking Glass ...	13,000,000	...	18,800,000
Bottles (110,000,000)	14,000,000	...	100,000,000
Crystal Glass ...	14,000,000	...	11,500,000
Drinking Glasses (*Gobleterie*) ...	10,000,000	...	21,000,000
Total	63,500,000	...	182,300,000

The weight of raw materials used is 220,250,000 kilogrammes, and of combustible fuel, 557,500,000 kilogrammes. The number of workmen employed is 19,700, pretty equally divided among the five branches of trade, and they receive wages amounting to a total of 18,000,000 francs.

Amongst the recent improvements introduced into the glass trade must be mentioned a new method of fusing glass, by means of a combination of combustible gases derived from coal, wood, or peat, with the aid of special apparatus. This transformation, which promises important results, is the most remarkable fact in the glass trade.

According to the Census of 1861 the number of persons engaged in the glass trade in the United Kingdom was 16,525, of whom 15,229 were males.

The following extracts from a report by Mr. H. Chance to the British Association at Birmingham, in 1865, will show the importance of some branches of this industry. The weekly produce of plate glass then made was about 100,000 feet. There are seven manufacturers of crown and sheet glass, three of whom make 75 per cent. of the whole quantity produced. The number of workmen employed in these three works is stated to be 2,500, and the quantity of glass produced 17,000 tons. There are no complete statistics of the manufacture of flint glass. The annual production of this description of glass in the Tyne and Wear district is estimated at 10,000,000 lbs., of which Birmingham produces about 5,000,000 lbs., and Stourbridge 3,500,000 lbs. annually. The make of glass bottles in the Tyne and Wear district in the year 1862, was stated by Mr. Swinburne to have been about 4,230,000 dozens. The subjoined table gives a complete account of the several descriptions of glass imported into the United Kingdom in 1865 and 1870:—

	1865.		1870.	
	Quantities cwts.	Value. £	Quantities cwts.	Value. £
Window Glass (except plate)	264,056	211,246	422,957	296,072
Flint Glass, cut, coloured, or ornamented	32,961	172,405	26,209	148,983
Ditto plain, including bottles	23,039	32,254	30,826	35,966
Plate Glass	28,631	133,613	35,298	164,725
Silvered Glass, or Mirrors	1,699	10,700	2,060	12,979
Bottles of green or common Glass	17,113	8,984	29,488	11,784
Manufactures, unenumerated	12,650	60,773	64,538	260,958
Total	380,149	629,975	611,376	931,467
	lbs.	£	lbs.	£
Beads and Bugles of Glass	3,365,221	178,310	2,112,081	124,183

Although many European markets are closed to the British producers of glass by the import duties levied, it will be seen from the following figures that our export trade has made great progress during the last twenty years:—

Quantities in Cwts.				
Year.	Flint Glass.	Window Glass.	Common Bottles.	Plate Glass.
1851	25,900	16,459	329,025	See Value below.
1855	39,295	21,537	513,140	
1860	79,544	33,408	629,511	
1865	99,314	50,955	622,496	
1870	101,755	77,022	614,288	
Value.				
	£	£	£	£
1851	110,666	22,223	174,318	20,743
1855	141,890	33,659	279,471	52,312
1860	222,380	44,063	324,189	62,566
1865	302,105	60,857	310,245	71,387
1870	253,723	90,270	306,763	145,509

The greater proportion of glass is made by hand labour, assisted by mechanical contrivances. The pressed glass manufacture is, however, chiefly carried on by machinery. Steam is also very generally employed in the processes of cutting, grinding, &c., in the flint glass trade.

Mr. Swinburne states that, "as regards glass processes generally, it cannot be denied that they present a great field for improvement." Much progress has, however, been made in many branches of the trade, amongst which may be specially noted the increase in the size of plates, sheets, &c.; the improvement in the colour of glass, and the advance of the "pressed" glass manufacture. The introduction of goods of this latter class has cheapened flint glass to such an extent, that almost the poorest of the population may be supplied with elegant articles of domestic use, which a few years ago were far beyond their reach.

The progress of the glass trade is mainly due (as has been before stated) to the repeal of the duties, which formerly hampered its transactions. On the removal of those duties, a great fall in the price of glass took place, and a vastly increased consumption was the result. The following prices of the leading descriptions of glass before the repeal of the duty, and at the present time, as stated by Mr. Chance, afford an interesting proof of the benefits that have been derived from the abolition of the duty, and of the advance of the glass industry generally. A mirror of plate glass 50 × 40 inches in 1844 cost about £10; in 1865, less than half the amount. Good crown glass per crate

in 1844 cost about £12; in 1865, £2 8*s.*; ordinary sheet glass per foot in 1844, 1*s.* 2*d.*; in 1865, 2*d.*

Had the glass duties existed in 1851, a Crystal Palace would have been almost an impossibility; on the other hand the repeal of the window tax has led to an extended use of glass in buildings of every description, and has materially added to the comfort and health of the population.*

The kinds of glass imported have been as follows:—

	1861.		1871.
Flint Glass ....cwts.	79,204	......	66,853
Window Glass .... „	35,732	......	421,613
Common Bottles, &c. „	546,216	......	105,598
Plate Glass .... „	—	......	38,919
Cwts.........	661,152	.....	632,983
Value of Imports†	£341,974	......	998,873

The declared value of the exports of British glass in the same years was as follows:—

	1861.		1871.
Plate Glass	£46,347	......	£160,824
Flint Glass of all kinds....	218,512	......	258,495
Bottles, &c. of green or common Glass	277,460	......	317,657
Window and other Glass	47,557	......	144,094
Total value of Exports ...	£589,876	......	£881,070

* Statistical Introduction to the "Official British Catalogue, Paris Exhibition, 1867."

† Exclusive of the value of bottles of green or common glass.

The window duty brought in a revenue to Government of, in—

1820	£2,578,581
1830	1,244,128
1840	1,350,930
1850	1,770,608
1851	1,878,800

The number of houses charged with duty in Great Britain was, in—

1820	968,008
1830	371,427
1840	394,036
1850	492,833

In 1825 the duty was repealed on all houses having not more than seven windows, and in 1851 the window duty was abolished, and an inhabited house duty imposed instead.

In 1845 the excise duty on glass, which yielded £600,000 to £700,000 to Government was given up, and since the remission of the duty the home use of glass and the export have largely increased; while the value of all descriptions of glass exported in 1850 only amounted to £308,346, the value of the glass exported in 1871 was £881,070. The abolition of the duty has, however, produced a somewhat paradoxical effect, which is thus stated by Mr. Chance:—

"While the quantity of glass made has increased in the proportion of three to one, the number of manufacturing firms has diminished in the proportion of one to two. In 1844 there were fourteen companies engaged in the manufacture. In 1846 and 1847—following the repeal of the duty—the number had increased to twenty-four. The glass trade, after the removal

of the heavy burden imposed upon it, seemed to offer a fair opening for money-seeking investment. The demand for glass was so great that the manufacturers were in despair. Glass-houses sprung up like mushrooms; joint-stock companies were established to satisfy the universal craving for window panes. And what was the result? Of the four and twenty companies existing in the year 1847, there were left, in 1854, but ten. At this time there are but six in the whole United Kingdom. Two established in Ireland have ceased to exist. In Scotland the Dumbarton works, once famous, were closed, in 1831, by the death of the partners; afterwards re-opened, and again closed. The six now existing are all English."

The increase in the production of glass in Great Britain is shown by the following statistics:—

		1820.	1830.	1840.	1850.
Plate	cwts.	8,855	14,296	33,623	66,000
Crown	„	97,309	98,287	141,864	240,000
Broad	„	7,253	5,635	9,051	—
Total		113,417	118,218	184,538	306,000

EXPORTS OF BRITISH MANUFACTURE.

		Window Glass.	Plate Glass.
1848	cwts.	19,708	value £15,242
1849	„	17,386	13,303
1850	„	15,518	18,335
1851	„	16,460	20,929
1852	„	22,168	21,866
1853	„	39,158	48,730
1854	„	35,514	59,294
1855	„	60,832	52,312
1860	„	112,952	62,566
1870	„	107,942	145,509

In 1854 we imported 31,639 cwts. of window glass (nearly all from Belgium), of which 27,127 cwts. were retained for home consumption; this, at the computed value of 14*s*. per cwt., was valued at £22,147. It paid 2*s*. 6*d*. per cwt. duty after 4th June, 1853. The quantity of plate glass, cast or rolled, whether silvered, polished, or rough, imported in the same year, was 794,194 lbs. At the average price of 9*d*. per lb. fixed for the value, this was worth £29,782, and it comes in free of duty. The great bulk of this glass—514,322 lbs.—came from France; nearly all the rest from Belgium, Holland, and the Hanse Towns. This seems principally to have been taken for re-export.

The total value of the imports of foreign-made glass of all kinds in 1870 was £931,467.

IMPORTS.

		Window Glass.		Plate Glass.
1848	cwts.	31,037	sq. feet	90,442
1849	„	25,557	„	68,106
1850	„	21,015	„	122,394
1851	„	12,298	„	174,448
1852	„	17,100	„	150,162
1853	„	27,577	„	221,304
1854	„	31,639	lbs.	838,982
1855	„	25,420	„	749,151
1860	„	141,468	„	—
1870	„	602,371	cwts.	37,358

The French are very much in advance of other countries in the manufacture of mirrors. The process of casting glass for that purpose was invented in the year 1685, by A. Thevart, a Frenchman. The first establishment for the manufacture of the article was the Royal manufactory of St. Gobain, commenced in 1691, during the reign of Louis XIV., and con-

tinued ever since, with constantly-increasing facilities for the prosecution of the business. There are at present two other manufactories in France—those of St. Quiver and Cirey, both of which belong to one company. The capital invested in this branch of industry is 32,000,000 francs, and it gives constant employment to about 12,000 men; indeed, the workmen are so numerous as to constitute, with their families, large villages, which have grown up around the respective factories.

The casting only is done at these establishments, the polishing and silvering being carried on at the extensive depôt of the companies in Paris.

The only place where the plates thus manufactured are sold, and in which the companies are all united in one interest, is the depôt in Paris, and its only branch, formed exclusively for the supply of the trade in the United States, is located in New York. From the well-known superiority of the French glass, their mirrors extend over the whole world, even to countries where similar manufactories exist.

All classes in this country, and in most wealthy countries, from the millionnaire down to the day-labourer, are patrons of mirrors and looking-glasses. The humble but tidy housekeeper buys the article in its least expensive form, as one of indispensable necessity. But with the wealthier classes, while it, in countless ways, subserves this purpose, it is also made to minister to the splendour of the drawing-room, the ball-room, or the saloon, not only as in itself a superb decoration, but imparting effect, by its reflection, to all other embellishments.

EARTHENWARE AND POTTERY.*

WHAT (remarks Mr. W. R. Sullivan) can be more simple than the art of the Potter? No tools of bronze or iron are required; the hands alone being capable of fashioning the prettiest-formed vases, whilst the materials employed may be found in abundance in every part of the globe, and require but a few readily shaped pieces of wood to prepare them for use. Hence we find vessels and other articles made of clay have been in use among the oldest nations of the earth —not alone among the Assyrians, Greeks, and Romans, but even among the old Celtic and Scandinavian nations, and the aboriginal races of America and Africa—of which many of the European museums preserve striking examples. It is probable that the first articles fashioned were drinking vessels; indeed, the word ceramic is derived from the Greek word for horn, apparently the first drinking vessel used in all countries; whilst the word pottery is derived from the Latin *potum*, a drinking cup. Another early application of the potter's art, though one which must undoubtedly have originated at a much later period than that of the manufacture of drinking vessels and other objects for domestic use, was to funereal purposes—vessels of clay for holding the ashes of the dead. The production of articles in terra cotta, or baked earth, may be considered to mark the first era

* Published in "Kelly's Post Office Guide to London, 1871."

in the Ceramic Arts, because it was only then that they acquired sufficient durability to call for the production of fine forms, or the application of ornament. According to the classification of Brougniart, Pottery may be conveniently divided into two great divisions:— 1. Pottery, properly so called; and, 2. Porcelain. The sub-divisions of the first class are:—

Soft Pottery—
Unglazed—Lustrous—Glazed—Enamelled.
Hard Pottery—
Fine Earthenware—Stoneware.

Soft pottery is composed of clay, sand, and lime, a mixture which would be represented by a common marly clay; it is easily scratched with a knife, very fusible, and hence the term "soft," applied to it. The subdivisions are founded upon the presence or absence of a glaze, and its nature; thus the garden pot represents the first subdivision, which would include bricks and tiles, and jars moulded or vases turned upon a lathe, whether pale-yellow, red, ashy-grey, or black. The ancient utensils and vases of Egypt, the old Roman water jars, the Spanish tinajas, alcarazzas, and some common pitchers, pans, and crocks, are examples of the first named colours; while Egyptian mummy cones, many bottles, and amphoræ of ancient Greece and Rome, and of Peru and India, chimney pots, milk pans, &c., are red; the old Celtic cinereal urns are examples of the grey; and the vases of Etruria and Volterra, among the ancients, and the black ware of Staffordshire among the moderns, represent the fourth colour. The second subdivision, or lustrous soft pottery, are simply the last mentioned

kinds covered with a very thin glassy coating, such as many of the Egyptian, Tyrrhenian, Etruscan, Greek and Roman vases of the finer kinds. The third subdivision consists of vessels made of the same materials as the first and second class, but covered with a thick varnish or glaze, produced by dusting the object over with lead ore, or with a mixture of lead ore and clay, sometimes coloured with oxides of other metals, as iron and manganese. The common glazed pottery of all the world affords examples of this kind. The fourth class, or enamelled soft pottery, is formed of much the same body as all the varieties mentioned, but is generally of a lighter colour, and is covered with an opaque enamel, consisting of a glaze made of sand and oxides of tin and lead. The opacity of the glaze, which depends upon the oxide of tin, hides the colour of the body or bisque, and admits, therefore, of this kind of ware being decorated with painting. The Moresco-Spanish and Catholic Spanish Azulejos, the articles made by Luca Della Robbia, Majolica or Faenza ware, Pallissy ware, Delft, Majolica of Nuremburg, &c., are examples of this kind of soft pottery.

Hard pottery is the intermediate stage between the soft clay wares and porcelain; its hardness and slightly vitrified appearance, distinguish it from the former, and its opacity from the latter. It is subdivided into two kinds :—1. Fine earthenware, in which the body is more or less white, and the glaze a lead-glass, of which Wedgwood ware was an example; and, 2. Stoneware, which is formed of more or less coloured clays, sometimes unglazed, or covered with a

soda-glass produced by the decomposition of common salt. Common jars, sewerage pipes, &c., are examples of this kind of ware.

Porcelain differs from earthenware by being translucent, being, in fact, an opaque paste of clay permeated by a kind of glass, exactly as paper is by wax in wax-paper. The body or paste is always hard, generally of a pure white colour, and, relatively to soft pottery, very infusible; and is, perhaps, in all instances, made of kaolin, derived from decomposed felspar. The glaze is formed of undecomposed felspar and quartz, with sometimes gypsum, boracic acid, &c., but never lead or tin.

There are three distinct kinds of porcelain, depending chiefly upon their relative fusibility, and consequently upon their composition. First, true, or porcelain with a naturally hard paste, composed of kaolin, and glazed with felspar containing quartz, which is hard and translucid, the glass not being liable to be scratched by a knife. Chinese, Japanese, Berlin, Dresden, and other German porcelains, and modern Sèvres (since 1769), are examples of this kind.*

The second kind of porcelain is much more fusible; the glass may be scratched with a knife. The body or paste is said to be naturally soft, and it consists of substances which may be fused with comparative facility. Modern English china which contains gypsum, bones, &c., is of this kind; so is old English china, such as Chelsea, Derby, Bow, and Worcester. The third kind is composed of difficultly fusible materials, but rendered fusible by the addition of salts, an example of which may be given in the case of

* "Inst. Industries, 1853."

old Sèvres, which is the typical example of this kind of porcelain, and hence said to be formed of a paste artificially soft. The celebrated Capo di Monti porcelain, from near Naples, and that known as Buen Retiro, from Madrid, are also examples of this kind.

Mr. Shaw, in his "Chemistry of Pottery," thus enumerates the successive inventions which were introduced into the manufacture of Staffordshire ware, and which led to the present unrivalled position of this great and important trade :—

"In this succession I find the common brown ware till 1680; then the Shelton clay (long previously used by the tobacco-pipe makers of Newcastle) mixed with grit from Baddeley Hedge, by Thomas Miles; of coarse white stone-ware and the same grit and can-marl or clunch of the coal-seams, by his brother, into brown stone-ware. The crouch-ware was first made of common potter's clay and grit from Moel Cop, and afterwards the grit and can-marl by A. Wedgwood, of Burslem, in 1690; and the ochreous brown clay and manganese into a coarse Egyptian black in 1700, by Wood, of Hot-lane. The employment of the Devonshire pipe-clay, by Twyford and Astbury, of Shelton, supplied the white dipped and the white stone-ware, from which the transition was easy to the flint-ware, by Daniel Bird, of Stoke; the chalk-body ware, by Chatterly and Palmer, of Hanley; and the Queen's ware, of the celebrated Josiah Wedgwood. Mr. Thomas Toft, introduced aluminous shale or fire-brick clay; Mr. William Sans, manganese and galena pulverised; Messrs. John Palmer and William Adams, common salt and litharge; Messrs. Elers Brothers,

red clay or marl, and ochre; Mr. Josiah Twyford, pipe-clay; Mr. Thomas Astbury, flint; Mr. Ralph Shaw, basalts; Mr. Aaron Wedgwood, red lead; Mr. William Littler, calcined bone earth; Mr. Enoch Booth, white lead; Mrs. Warburton, soda; Mr. Ralph Daniel, calcined gypsum; Mr. Josiah Wedgwood, barytes; Mr. John Cookworthy, decomposed white granite; Mr. James Ryan, British kaolin and petuntse; Messrs. Ladler and Green, glaze printing; Mr. Warner Edwards, biscuit painting; Mr. Thomas Daniel, glaze enamelling; Mr. William Smith, burnished gilding; Mr. Peter Warburton, printing in gold; Messrs. John Hancock, John Gardner, and William Hennys, lustres; Mr. William Brooks, engraved landscapes and printing in colours; Mr. William Wainwright Potts, printing by machine and continuous sheets of paper; and the same gentleman, with Mr. William Machin and Mr. William Bourne, for printing flowers, figures, &c., in colours, by machine and continuous sheet of paper."

The earthenware is generally ornamented by printing, some of the prints being filled with enamelled colours. It may be printed from copperplates, with one or many colours, as effected by Mr. Pratt, of Friston. It may be also printed in flat and varied tints, as in Mr. Minton's manufactory, by a process similar to that employed for polychromatic printing. "The Ceramic," observes M. Arnoux, "is one of those choice manufactures which requires from those who devote themselves to it a great amount of knowledge; in the present day a potter ought not only to be an artist to decide which is the best shape to be

given to the piece used for decorative or domestic purposes, but he must also be well acquainted with geology, chemistry, and natural philosophy; for he will have to sort out his materials from the bosom of the earth, to combine clays and colours, and make subservient to his will air, water, and fire. This is the reason why great potters were so scarce when these sciences were in their infancy."

A very limited number of countries can supply themselves with earthenware or china—those precisely in which the arts and sciences are the most advanced. The immense continent of America has not produced to this day anything of the kind worth mentioning; and, if we put aside the Chinese, we shall not find more than three nations who can export pottery to any extent—England first, then France, afterwards Germany; but the last to a much smaller degree.

Nature has taken care to provide England largely with all the materials necessary for the potter's work. Clay, flint, kaolin, and felspar exist here in abundance; and to fire these we have mineral fuel sufficient for several centuries.

The Census of 1861 gave, among the occupations of the people, 38,072 as engaged in the earthenware manufacture in England and Wales, and 31 others working or dealing in it; 59 of these were clay merchants, and 2,912 labourers in clay. There were 171 flint grinders, 53 encaustic and mosaic tile makers, 80 making parian, and 28 terra cotta. In Scotland there were also at the taking of the Census 2,517 operatives engaged in the earthenware and porcelain manufactures, and 108 in Ireland, but there are

probably 750,000 men, women and children employed in the various departments of the trade.

The value of British earthenware and porcelain exported from the United Kingdom was in :

1850	£999,448
1855	1,000,738
1860	1,450,644
1865	1,442,697
1870	1,637,026

In 1852 the annual production of the English potteries was estimated at £2,000,000, 185 factories being then engaged in this important branch of the national industry; 52 were scattered over the country at Leeds, Stockton, Sunderland, Glasgow, Bristol, Swansea, &c., and 133 in North Staffordshire, where 60,000 persons were all, more or less, engaged in this manufacture, forming the district usually called "The Potteries." The aggregate population now engaged in the manufacture, or dependent on it, is about 150,000, and the population of the parliamentary borough of Stoke-upon-Trent is 120,000; but it is spread in long, thin strips over a large area, of about eight miles in length and of about half the distance in width. Here is not one huge conglomerate, but at least six towns—Longton, Fenton, Stoke-upon-Trent, Hanley, Burslem, and Tunstall. There are at least in this district 18,000 men potters, in the receipt of high wages, of whom more than half have by care and industry purchased their own freehold, and are now living in their own houses. There are also about 11,000 women and children employed in the lighter branches of this beautiful manufacture.

There are a large number of rooms, and only a very few operatives in each. Each potter works independently. There is a great demand for fineness of touch, sense of form, and manual dexterity, and but little use of machinery, beyond the potter's wheel—that most ancient tool of man's industry. The steam-engine is scarcely anywhere employed, except in the primary process of mashing the clays and grinding the flints. The clay is ground between two stones, just as the grain is in a flour mill. The potter deals with the dough of clay just as the baker or confectioner deals with the dough of flour. When the ball of dough receives its motion of rapid rotation on the wheel, then the "thrower," as he is called, by the exquisitely fine touches of his thumb and fingers and palm, shapes the plastic clay to its destined form, to be afterwards completed by the hands of the turner, who also works at a wheel by a process exactly similar to that of a wood-turner at his lathe. Another class of ware is formed by moulding. It is a work of individual skill. Years are required to make a good thrower, and a very short cessation from the work impairs the extreme fineness of touch which is essential. The hand for any considerable time out of the employment would lose its pliancy and contract a coarseness. One cannot help looking at the potter's wheel with a degree of veneration. There you see it whirling before you just as it did in the infancy of the human race, just as small and simple as it was then, and contributing as powerfully as ever to the daily wants of mankind. Those wants it always satisfied, but now the Ceramic Art has reached

a splendour which makes it one of the joys of daily life.

The great progress that has been made is evidenced in the general adoption and high improvements of terra cotta. The beautiful works shown by the Watcombe Terra Cotta Company in vases and jars, brackets, busts, and figures, have commanded general admiration, both for their good taste and excellence of finish, and led to an extensive home and foreign demand.

The raw materials used in the manufacture are chiefly produced in this country—in the counties of Dorset, Devon and Cornwall. According to the official returns, the production of clay and china stone in the year 1865 amounted to 374,358 tons; 751,566 tons of fire clay were also raised in the counties of Stafford, York, Derby, &c. In 1870 the production of clay and china stone in Cornwall and Devon was 201,000 tons. The quantities of prepared clay annually consumed in the Staffordshire potteries is stated to be about 160,000 tons, and the quantity of fine and fire clay raised is estimated officially at 1,200,000 tons, of the value of £450,000. The shipments of kaolin or china clay and china stone from Cornwall were, in 1869, 134,200 tons; from Devonshire, 56,200 tons; from Dorset, 60,210 tons of clay. The wages paid in Worcester and its neighbourhood in the porcelain manufactures in 1868 was—clay makers, men, 24*s.* (per week); throwers, men, 40*s.* (per week, piece work), lads and boys, 14*s.*; turners, men, 40*s.*, lads and boys, 7*s.* 6*d.*; handlers and pressers, men, 30*s.* to 40*s.* (per week, piece work); figure makers, men, 30*s.* to 50*s.*, lads

and boys, 10*s.*; modellers, 40*s.* to 63*s.* (per week); moulders, 30*s.* to 36*s.*; saggar makers, 30*s.* (per week, piece work); biscuit firemen, 40*s.*; biscuit placers, 18*s.* to 20*s.*; glost firemen, 42*s.*; glost placers and kiln firemen, 25*s.*; painters, 30*s.* to 80*s.* (piece work); gilders, 25*s.* to 36*s.* (piece work); enamellers, women, 10*s.* to 14*s.* (per week); girls, 2*s.* to 5*s.*; burnishers, women, 8*s.* to 12*s.*, girls, 2*s.* to 5*s.*; engravers, 25*s.* to 30*s.*; 11 hours per day. There are in Cornwall 100 porcelain clay works; and in Devonshire, of porcelain and Teignmouth clay 10, of Poole clay works 11; and of Stourbridge clay in Staffordshire 16.

The annual consumption of coals in the potteries and brick works of Staffordshire may be stated at 675,000 tons. To stain the clay and print the ware about 70,000 lbs. of oxide of cobalt is used and about 1,200 tons of borax and boracic acid to glaze it, and 12,000 ozs. of gold are required to gild and embellish the same. The amount of calcined bone used in the manufacture of china is about 4,500 tons per annum, obtained principally from South America.

There are about 25 potteries in the Newcastle district (on the Tyne, Wear, and Tees); of which on the Tyne, 6 manufacture white and printed ware; 4, white, printed and brown ware; and 3, brown ware only; employing 1,200 people, and manufacturing yearly about 12,000 tons of white clay and 3,000 tons of brown clay, and consuming in the process of manufacture about 34,000 tons of coals: on the Wear there are 2 potteries, manufacturing white and printed ware; 2, white, printed and house ware; and 2, brown ware

only; employing about 500 people; manufacturing yearly about 4,000 tons of white clay, 1,500 tons of brown clay, and consuming in the manufacture 14,000 tons of coals: on the Tees there are 4 potteries, manufacturing white and printed ware, employing 500 people, manufacturing 5,000 tons of white clay, and consuming 13,000 tons of coals: 2 potteries at Norton, manufacturing brown ware. The potteries in this district being situated upon navigable rivers have great advantages over their inland competitors, Staffordshire and Yorkshire.

The expenses on clay from sea freight and inland carriage average 13*s.* per ton to Staffordshire, and 5*s.* per ton to the Northern district; and in flints the advantage is still greater, in Staffordshire the average being 19*s.* per ton against 4*s.* 6*d.* per ton in the North. Coals are a little dearer, but much superior in quality to Yorkshire or Staffordshire.

About twelve years ago, Messrs. Skinner and Co. of Stockton-on-Tees, first applied Needham and Kite's patent filtering press for expelling the surplus water from the slip, which had formerly been done by evaporation. This is a much cleaner and better process than the old system, and is now adopted by thirty or forty potteries in England and Scotland.

With the exception of three potteries in the Northern district and at Glasgow, machinery has been very little applied to the manufacture of earthenware, and, even at those works, not nearly to the extent to which it is capable of being profitably adopted. One manufactory on the Tyne, the Ford Pottery, having the best machinery, supplies at least 80 per cent. of the jars used

by confectioners for marmalades and jams, &c., in England and Scotland. The description of goods manufactured in the North is that used by the middle and working classes, no first-class goods being made there.

The Lambeth potteries make principally stoneware, such as bottles, jars, pans, drain and water pipes, &c.

There is also a large manufacture of fire-clay goods in the kingdom, which are made principally at Newcastle and Stourbridge. At the former, upwards of 90,000,000 fire bricks are now made per annum, 12,000 to 15,000 fire-clay retorts for gas works, and 175 miles of glazed pipes from 3 inches to 15 inches in diameter. About 300,000 tons of clay, and 150,000 tons of coal, are required in the manufacture, and nearly 4,000 men and boys are employed. Repeated attempts have been made to apply machinery to the production of fire bricks, but as yet without success. The wages in the fire-clay manufacture at Newcastle and neighbourhood is—for brick makers, men, 18*s.* to 24*s.* per week of 55 hours; clay retort makers, men, 24*s.* to 27*s.*, women, 5*s.*, labourers, 10*s.* to 18*s.*, lads and boys, 1*s.* 6*d.* per day.

The plastic nature of the fire clay, with the character and variety of the articles made from it, renders the application of machine power difficult, and the advantages derivable from its application comparatively trifling. Machinery has, however, been very extensively and successfully applied to the preparation of the raw material. Indeed, had it not been for the improved mode of grinding and pugging the clay which machinery has supplied, it is doubtful whether

the trade could have developed in the way it has done.

The average rates of wages paid to operatives in the Staffordshire district in 1866 ranged—for males, from 1*s*. 6*d*. to 7*s*. per day, for females, 1*s*. 6*d*. to 1*s*. 8*d*. per day. At Worcester, for males, 16*s*. to 50*s*. per week, for females, 10*s*. 6*d*. to 14*s*. At Newcastle, for males, 10*s*. to 30*s*., for females, 10*s*. per week. In the earthenware manufacture at Newcastle, the weekly wages in 1868 were—for clay makers, men, 3*s*. 6*d*. to 5*s*., women, 9*s*. to 10*s*. (piece work); throwers, men, 22*s*. to 28*s*. (piece work), women, 9*s*., girls, 4*s*. 6*d*.; turners, men, 20*s*. to 24*s*., women, 8*s*.; handlers, men, 22*s*. to 24*s*., lads and boys, 4*s*.; pressers, men, 24*s*. to 32*s*., lads and boys and girls, 3*s*. 6*d*. to 5*s*.; modellers, men, 27*s*.; moulders, 30*s*. to 36*s*.; saggar makers, men, 20*s*. to 24*s*., lads and boys, 4*s*. 6*d*.; biscuit firemen, 24*s*. to 30*s*.; biscuit placers, men, 24*s*., lads and boys, 10*s*. to 15*s*., women, 8*s*.; printers, men, 20*s*. to 25*s*., ditto transferrers, women, 10*s*. to 12*s*., girls, 3*s*. to 4*s*.; glost firemen, 24*s*. to 30*s*.; glost placers, men, 24*s*., women, 8*s*. (hours of labour, 59 per week); painters, 20*s*. to 24*s*.; transferrers, women, 10*s*.; burnishers, 16*s*.

Declared value of the Earthenware and Porcelain exported in the last ten years :—

1862	£1,220,247	1867	£1,635,216
1863	1,341,069	1868	1,642,550
1864	1,422,014	1869	1,725,274
1865	1,422,197	1870	1,637,026
1866	1,650,019	1871	1,728,914

DYES AND COLOURING STUFFS.*

Of the several classes of materials collected at the International Exhibition in Hyde Park (1851), few possessed so much importance in the eyes of the textile and leather manufacturer and chemist, as the different products used in the arts and manufactures for colouring and tanning purposes. These were in a great measure lost sight of by the public at large; being scattered about over the building in a great number of directions; and, from the small samples shown, were in many instances overlooked altogether. The object of the present paper is to bring them collectively into view, and to furnish a few new and general statistical facts, which, besides proving interesting, may serve to draw attention more prominently to some which are at present little known or appreciated.

Colouring substances for staining and dyeing are obtained indifferently from the animal, mineral, and vegetable kingdoms, but it is to the last named that we would principally call attention. The importance of a more careful consideration of this subject will be admitted, if we consider how much the prosperity and progress of our cotton, silk, woollen, and leather manufactures depend on a liberal and cheap supply of dyes and tannin, to give beauty and colour to the fabrics. Even oil colours, for painters' pur-

* Published in Lawson's "Merchants' Magazine," 1853.

poses, which scarcely come within the scope of our remarks, form an item in our yearly exports of the value of £250,000,* and when we consider the large amount of cotton, silk, and wool worked up, most of which requires various colouring agents, gums, starches, and mordants—that nearly 33,000 tons of hides are imported exclusive of those obtained from our own slaughterhouses, besides seal skins—and that the export of our various manufactures of cotton, linen, silk, and leather in 1850 exceeded in value £45,000,000 sterling, we shall be able to form a better estimate of the importance of the various substances we are about to notice.

Great Britain does not pay less than £600,000 annually for the dried carcasses of the tiny cochineal insect, while the produce of another small insect, that which produces the lac dye, is scarcely less valuable. Then there are the gall nuts used for dyeing and making black ink. Upwards of £3,000,000 is paid for barks of different kinds, for tanners' use; about £1,000,000 for other tanning substances and heavy dye-woods, besides about £200,000 for various extracts of tannin, such as gambier, cutch, and kino. The aggregate value of the dyestuffs and gums it is difficult to estimate.†

The beautiful specimens of dyed fabrics, &c., imported from China, India, New Zealand, the Continent, and other countries, and shown at the Exhibition, prove to us that we have yet much to learn from other

* In 1871, it was over £1,000,000.

† See statistical returns at the end of this paper for official figures.

nations in the art of fixing colours and obtaining brilliant dyes. The French are much our superiors in dyeing and the production of fast and beautiful colours. Their chemical researches and investigations are carried out more systematically and effectively than our own.

Dyestuffs are usually divided into two classes: 1st, Substantive, such as are capable alone of imparting fast colours, among which are indigo, catechu, and the metallic oxides. 2nd, Adjective, those which require the intervention of a mordant, as madder, cochineal, and yellow berries.

DYES OBTAINED FROM THE ANIMAL KINGDOM.

The fine Tyrian purple dye, now as in former days celebrated for the singular brightness of its red colour, is obtained in the Mediterranean from *Murex purpura*, a species of mollusc, and from *Purpura persica;* the Norwegians procure the dye from *Buccinum lapillus*. The colouring matter, when first obtained and applied to linen, silk, or paper, with a hair pencil, becomes of a bright yellow and gradually changes to pale green, afterwards assuming a deep and brilliant purple.

The renowned Tyrian dye was taken from a white vein in the throat of the *Purpura*. It was of a dark-red colour, resembling a deep rose. The purpuræ of the best description were chiefly found on the rocks of Tyre on the coast of Asia; they were also caught at Meninge on the Graetulan shores in Africa; and on the coast of Laconia in Europe. The colours varied according to the locality in which the molluscs were taken. Those from Pontus and Galatia, being in the

north, produced a black dye; in the equinoctial regions a violet hue prodominated; whilst in the south, as at Rhodes, the colour was of a richer red. These purple shell-fish were also called "pelagia;" and they were distinguished by the district as well as by the food which the locality supplied. Two hundred *buccinæ* were added to one hundred and eleven *pelagiæ*, to make the purple colour so much eulogised by Pliny, and one of the three shades of purple recorded by the ancients. Vegetable colours, kermes, and other mixtures, were also resorted to for additional splendour and variety. To make a purple dye they mingled several kinds of fish, adding, at one period, nitre, urine, water, salt, and fucus. But the dye from the *Buccinum* required only pure water.—Linton, "On Ancient and Modern Colours."

With the destruction of the ancient city of Tyre, the beautiful art of dyeing this peculiar colour was lost for centuries, until it was again recovered by the scientific men of our country. Mr. Cole, in the "Philosophical Transactions," has given an account of the method by which it was obtained. The discovery would probably have been of great value to our commerce had not the use of it been rendered unnecessary by another natural history discovery, namely, the cochineal insect. By the use of the dead carcasses of this insect we can produce colours, such as crimson and scarlet, of a more beautiful and permanent description even than those which were in the greatest repute among the ancients.

Murex brandaris and *truncatus*, other purple shells of the ancients, are found on the coast of the Pacific,

especially along the shores of Upper California and in the bays of Tehuantepec and San Francisco. The Indians avail themselves of the colouring matter to dye cotton. *Helix janhana*, which occurs in the Mediterranean, Atlantic, and South Seas, affords a similar fluid. Sepia, the dried ink bag of the *Sepia officinalis*, may be mentioned, although scarcely a commercial article.

There are no other dyes obtained, that I am aware of, from fishes or inhabitants of the sea, certainly none deserving of particular mention here. The insect tribes furnish several, the most remarkable of which are the lac and cochineal dyes, and galls, principally used in tanning and chemistry.

Lac, in its various commercial forms, is the resulting product of the punctures of *Coccus ficus* or *C. lacea*. The colouring substance obtained from stick-lac, affords a rich scarlet dye, little inferior to cochineal, and it is in general use for dyeing in the East. The lac insect is found chiefly on hilly parts of Hindostan, on both sides of the Ganges. A white, wax kind of lac has lately been found near Madras. Lac is a staple production of the wild tract of country to the eastward of the Godavery river. Within a round of twenty miles of Mahadrapore alone, some thousands of rupees' worth is yearly produced. By making advances to the Goands, a writer in the "Bombay Times" states that he collected large quantities of it for the Hyderabad market, and a great deal more for the same place was carried away by others. If it were an object to encourage the supply of this article, which is met with wild in every part of this vast tract, without any

artificial aid whatever, very considerable quantities might be collected annually. The native process of preparing it is very rude, and in consequenee, perhaps, much of its value is deteriorated: under European superintendence that would be soon rectified.

About 9,500 cwts. of stick-lac are annually exported from Siam. According to Crawfurd, the lac insect exists in most of the forests of the Indian Islands, but especially in those of Sumatra and the Malayan Islands. Its produce is, however, inferior to that of Bengal, and especially of Pegu, which countries chiefly supply the large consumption of the markets of China; while the lac of the Indian Islands is principally used locally. The quantity of lac dye entered for home consumption, in 1850, was 11,541 cwts., besides 6,600 re-exported. The basis of lacquers is a solution of seed-lac or powdered shell-lac in spirits of wine; the colouring substances used being gamboge and arnotto.

The lac dyes are prepared by extracting the peculiar colouring matter of the stick-lac of commerce; this latter is a resinoid substance, the result of a secretion of several different plants—the *Ficus indica*, *F. religiosa*. *Croton lacciferum*, and others, occasioned by the punctures made by a small insect for the purpose of depositing its ova; the branches become encrusted with a reddish-coloured concretion, which consists of the inspissated juice of the plant, imbued with a peculiar colouring matter, derived from the insect; the preparation of them is usually carried out in India, the remaining substances, seed-lac and shell-lac, being also articles of commerce.

"Lac dye" is a term commercially applied to the

colouring matter extracted from stick-lac; the latter is considered to be the resinous secretion of a tree, on being punctured by an insect common in many districts of Eastern India. This insect is found in enormous numbers in the forests of the mountains on the sides of the Ganges. The insect, when about to deposit its eggs, attaches itself to the branches of trees, and soon becomes enveloped in a layer of gummy matter, which hardens on exposure; the insect dies, and its body shrivels into an oval bag, containing a minute drop of red fluid; this is extracted from the lac, and when formed into small masses, becomes the lac dye of commerce. In 1848, 1,221,308 lbs. were imported into the United Kingdom.*

Kermes, another insect of the same family (*Coccus ilicis*, Linnæus, *Chermes vermilio*, Noble), is common in the south of Europe, upon the *Quercus coccifera*, *Q. ilex* and its varieties; it is met with in Spain, France, Greece, and the Levant.† The Spanish kermes (which must not be confounded with the kermes *mineral*) is preferred to the French. About Seville they dry the gall-shaped nests of this insect's eggs on mats in the sun. The dust which arises from stirring it about is considered the most valuable part, and, when mixed with vinegar, is called "pastel," being used as a carmine.

* A Paper on the "Natural History of the Lac Insect," by W. J. Carter, F.R.S., will be found in vol. i. of my "Technologist," p. 196, and "Some Remarks on Shellac, with an Especial Reference to its Present Commercial Position," by John Mackay, in the same vol., p. 204.

† Dr. Gustave Planchon has published a good monograph lately, "On the Kermes of the Oak." Paris: Savy, 1864.

colour to a bright red hue, for which they have so long been celebrated.

It was known to the Phœnicians before the time of Moses under the name of *thola*, to the Greeks' by the appellation of *Coccus baptica*; hence the origin of the word "coccinati," the persons who wore robes that were dyed with the kermes. Previous to the discovery of America kermes was employed to a great extent in dyeing a very rich blood-red, which is of so permanent a nature that the old tapestries of Brussels and other parts of Flanders, although manufactured more than two centuries ago, have lost none of their richness of tint. Since the settlement of America it has been supplanted, in a great degree, even in Europe, by cochineal.

The kermes, nevertheless, is still extensively prepared in some parts of Spain as well as in the East. Bancroft states, in his "Permanent Colours" that, with a solution of tin, which is used with cochineal, the kermes is capable of imparting a scarlet quite as brilliant as that dye, and perhaps more permanent. At the same time, however, as ten or twelve pounds contain only as much colouring matter as one pound of cochineal, the latter, at its ordinary price, is more economical. At present it is chiefly used at Tunis, and other parts of the Barbary coast, for dyeing the scarlet skull-caps (*fezes*), so much used in the Levant. In the department of the Bouches-dû-Rhone, one-half of the kermes crop is dried. It amounts annually to about 60 cwts., and is warehoused at Avignon. From the middle of May to the middle of June the egg-cases are collected, and exposed to the vapour of vinegar to

prevent incubation. A portion of the eggs is left on the tree for the maintenance of the brood. The species of oak on which the kermes insect is found abounds in Algeria, principally in the provinces of Algiers and Oran; but neither the tree nor the insect are an object of any careful attention. The Arabs, however, collect the insect in June, and the price at which they dispose of it has ranged of late years from five to ten francs the kilogramme. The exports of kermes from Algeria are about 4,000 lbs. annually, which, at the official price of 4*s*. per lb., gives a total value of £800. It is used to dye stuffs red, instead of cochineal, for colouring distilled waters, cosmetics, and pharmaceutical preparations. *Coccus polonicus* makes similar nests for its eggs on the roots of the *Polygonum cocciferum*, *Scleranthus perennis*, *Lycopodium complanatum*, and other plants in sandy soils in France and the Ukraine. The kermes called *Coccus fragaria* is found principally in Siberia, on the root of the common strawberry. The *Coccus Uva-ursi*, which occurs in Russia, is twice the size of the Polish kermes, and dyes with alum a fine red. Good kermes is plump, of a deep red colour, of an agreeable smell, and a rough and pungent taste. Its colouring matter is soluble in water and alcohol; it becomes yellowish or brownish with acids, and violet or crimson with alkalies. Sulphate of iron blackens it. With alum it dyes a blood-red; with copperas and tartar, a lively grey; with sulphate of copper and tartar, an olive green; with tartar and salt of tin, a lively cinnamon yellow; with more alum and tartar, a lilac; with sulphate of zinc and tartar, a violet. Scarlet and crimson dyed with kermes were

called grain colours, and they are reckoned to be more durable than those of cochineal. Hellot says that previous to dyeing in the kermes bath he threw a handful of wool into it, in order to extract a blackish matter which would have tarnished the colour. According to Wolfe one pound of kermes is capable of dyeing ten pounds of wool; but Hermstadt could not obtain a pure colour, although he employed five times as much of it as of cochineal. The colour does not take well on silk. The Turks, Armenians, and Cossacks, dye with kermes their morocco leather and cloth, as well as the manes and tails of their horses, and the females the nails of their fingers.

A second species worthy of attention, which feeds on a *Poterium*, was formerly much used by the Moors in dyeing their wools and silks. A diminutive mite, the *Trombidium tinctorium*, of Fabricius (the *Acarus tinctorius*, Linnæus), occurs in Guinea and Senegal, and yields a valuable dye, in common use amongst the native tribes. Monsieur Caillaud ("Voyage à Meroe") met with it in Sennaar.

The next dye for consideration is the beautiful crimson or scarlet, furnished by cochineal.

Cochineal, the *Coccus cacti*, which infests the *Opuntia coccinellifera*, and other species of cactus, yields the cochineal of commerce. The insect was formerly confined to Mexico, where the culture was carried on by the Indians, and afterwards the Spanish settlers derived an immense profit from the export of the dye. About the year 1778 the French Government managed to introduce the insect, and the peculiar species of cactus on which it flourishes, into their

West India colonies. Large grants were made for promoting the culture, and the import from St. Domingo was at one time considerable. Within comparatively few years the production of cochineal has been so successfully carried out in various parts of the Old World, that the quantity annually produced now rivals the whole amount obtained from Central America. Soils unfit for other cultivation will readily support the cactus on which the insect feeds, and the produce is less precarious than that from the silkworm. In 1831 the culture was commenced in the Canary Islands, and in 1849 the imports to France and England had reached the large amount of 800,000 lbs. The French Government have commenced plantations in Algeria, where they promise to succeed admirably, and specimens of cochineal already exported have been pronounced superior to the finest Mexican.* Attempts have been made to rear cochineal in the Mauritius, and the island abounds with the true cactus, but a small bird which preys on the insect has been found a fatal destroyer.

About eight years since the cochineal insect was introduced into Curaçoa through the exertions of the Governor, Von Raders. The expenses of the Government plantations on that island, and its appendages of Bon Ayre and Amba, were repaid by the produce, and a profit yielded of 20,000 to 30,000 dollars by the exports in 1849, so that private individuals are now following the Government example.

* A good descriptive article, by M. Simonnet, on the modes adopted of rearing and breeding the insect in Algiers, will be found in the "Pharmaceutical Journal," vol. iii, p. 581.

The cochineal cactus was introduced into Java by the Dutch Government in 1830; and although the culture is only carried on at a few Residencies, yet so rapid has been the progress that 173,000 lbs. were raised in the island in 1851.

Ibrahim Pasha successfully introduced the insect into the vicinity of Tripoli, where the *Cactus opuntia* thrives remarkably well. After Bombay, Guzerat, the Concar, and the Persian Gulf seem to be the chief places of consumption of cochineal in the East, and China appears latterly to have come into the market. It is somewhat singular that a people so remarkable for their skill in the manufacture of colouring matters should not supply cochineal for themselves, and I can only conclude that, like cotton, they find it cheaper to purchase than to produce, when agricultural industry can be turned to a better account in other directions. The climate of Japan and China being similar to Mexico, the culture will, doubtless, be introduced there before long, as cochineal is so indispensable an article for dyeing silks of scarlet and crimson colours.

At the close of the eighteenth century, through the instrumentality of Sir Joseph Banks, the East India Company set on foot experiments for the production of cochineal in the East. A nopalry was established at Madras, under the management of Dr. Anderson and Dr. Berry, and in three years 2,000 *Opuntia* plants were in a flourishing condition. The native cactus (*O. Dillenii*), however, was found to be the only plant on which the imported insects throve. When the harvest came to be gathered, it was dis-

covered that a sad mistake had been made; the insect introduced and diffused over the country at such expense was found to be the wild cochineal, and not the real *grana fina* of Mexico. Thus both the imported insect and cactus were discovered to be inferior species; and though a reward of £2,000 was offered by the Indian Government for the introduction of the true Mexican insect, it was never claimed. The wild insect occurs very generally on the *Cactus indicus* throughout India, and is found in great abundance, particularly in the North West Province. It takes, however, four times the quantity of this insect to produce the same amount of colour as the cultivated species. Dr. Royle ("Productive Resources of India") thus accounts for the abandonment of the culture in India. "The experimental culture in India was as successful as could be expected with the materials at that time obtainable, and sufficient was learnt to satisfy every one that the true cochineal insect would thrive well in the districts where the wild kind had spread with such amazing rapidity. The Government patronage, though liberal enough to have established the culture even of the true insect, had only a temporary effect upon that which was so inferior, as the increased employment of lac, and the diminished price of cochineal, combined their efforts in discouraging the culture."

The imports of cochineal have rapidly increased within the last few years, and our home consumption has become larger. While we imported only 14,600 cwts. in 1847, in 1850 the imports had reached 22,500 cwts., of which we retained about 12,500 cwts. The best

accounts of cochineal culture will be found in Dunlop's "Travels in Central America," Stephens's "Incidents of Travel," and in a rather scarce work published in French, at Port-au-Prince, many years ago, by M. Thierry de Meneville, the Government botanist of St. Domingo.

A few years ago Mr. David Riz, of Kingston, Jamaica, made experiments to obtain from the cactus plant artificially what nature accomplished in the insect, and at length succeeded by inspissating the delicate ripe juice of the succulent fruit. After a number of experiments, he found one process which communicated a crimson colour to silk and wool superior to that given by cochineal. He came to England, and trials of the same were made before a number of the principal dyers in and about London, at the Museum of the Royal Institution. He also discovered two other processes, which promised, with very little alteration in their manufacture, to produce the colouring dyes of scarlet and purple. Upon a moderate calculation it was found that this colour would go further than three times the quantity of cochineal, which he accounted for by remarking that there is a great part of the insect, as its skin, &c., which affords no dye; but that the whole of his process yielded genuine colour, with little or no impurity. Notwithstanding the advantages that might be derived from this gentleman's discovery, he met upon the whole with very little encouragement to prosecute his manufacture and pursue his investigations, although the sums annually expended in the purchase of cochineal from foreigners are very large, and thousands of acres,

now waste in our West Indian and other colonies, might be cultivated with the cactus plant at very little trouble and expense, and a quantity of dye obtained fully adequate to the home demand. The fruit of the *Opuntia* when eaten gives a red colour to the urine. Mr. Warren de la Rue undertook a series of careful investigations of the colouring matter of cochineal in the Royal College of Chemistry, but could not in any way connect the red colour of the insect with that produced by the fruit.

The beautiful pigment, carmine, is a result of the precipitation of an infusion of the cochineal insect (*Coccus cacti*) in water by means of alum. The carmine of commerce is so costly an article that it is seldom to be met with in a state of purity. Pure carmine dissolves in ammonia.

The insect by the puncture of which oak galls are formed, is the *Cynips quercusfolli.* Galls are shipped in considerable quantities from Messina in Sicily, and from Smyrna, for the English, German, and French markets, the two former, however, being the largest consumers; for England, the blue galls are those principally sent. The annual produce of all sorts is about 5,500 quintals, of 125 lbs. each. A very curious gall has lately been imported from China by Mr. Morson, F.L.S. This, which is principally composed of gallic acid and tannin, has been particularly described in a volume of the "Pharmaceutical Journal," where the insect is figured. Gallic acid is of extensive use for dyeing, as it constitutes one of the principal ingredients in all the shades of black, and is employed to fix or improve

several other colours; it is also used as a chemical agent, and in the manufacture of black ink. Nut galls contain about 40 per cent. of their weight of tannin. About 280 tons of galls were imported into Liverpool last year (1852).

The peasants of Thrace and Macedonia collect the galls, which grow on the leaves of the male terebinth, about the end of June. They are then about the size of a small hazel nut, but, if left a sufficient time, would become bow-shaped, and about six inches long. About 6,000 lbs. of these galls are annually sold at a high price, being in much local demand to dye fine silks in the town of Brussa. Galls are also obtained from the pistachio, growing in Cabool, Bokhara, and Persia.

MINERAL COLOURS AND DYES.

The earthy and mineral substances used for colours are, white lead, zinc, red lead, umber, ochre, ultramarine, sulphate of cobalt, manganese, copper, iron, arsenic, and some other substances, the careful proportioning and compounding of which come mostly within the province, in the first instance, of the chemist. Prussian blue and chrome yellow are also metallic compounds. In 1850 we imported 78,950 lbs. of prussiate of potash (worth about £6,000), to form Prussian blue; and from France, in 1851, 8,148 lbs. Hundreds of tons of the sulphates of ores are used by various manufacturers, the sulphate of manganese to give a brown colour in calico printing, the sulphate of copper for emerald and Brunswick greens, the sulphate of iron for Prussian and other blues, and the sul-

phuret of arsenic is also a valuable pigment. About 1,000 tons of argol, the deposit from wine casks, which is used as a mordant, are imported annually from the wine-producing countries. 10,000 to 12,000 cwts. of various ochres, valued at £8,000 to £9,000, are supplied to us annually by France, for the use of painters and paper stainers, &c., which might, in some measure, be procured from our colonies, as good specimens were shown at the Great Exhibition, in 1851, from Singapore, Patna, and Canada, &c. Carbonate of ammonia is also much used in colour-making and dyeing.

The oxide of cobalt gives an intense and beautiful blue colour to earthenware and glass; when fused with silica and potash, under the name of smalts, it is extensively used for dyeing linen, paper hangings, &c. The phosphate of cobalt, with alumina, furnishes nearly as beautiful a blue as ultramarine.

Zaffres is a sort of regulus of cobalt, which is imported to the extent of about 80 tons; when smelted over again, mixed with potash and siliceous earth, it forms smalts; this, when ground fine, is called powder blue. About 200,000 lbs. of smalts are annually imported.

Polychromate, or chrysammic acid, a new dye, was shown at the Exhibition by Mr. P. Sants, of Utrecht, with specimens of silk coloured with it.

Ultramarine, one of the most valuable pigments, by the application of science and the analysis of its component parts, has been now so materially cheapened that it has come into general use for the purposes of the painter, printer, and varnisher. For preparing

artificial ultramarine, a Council Medal was awarded by the Commissioners of the Exhibition of 1851 ; and nine other medals were given for beautiful specimens of ultramarine shown. Austria exhibited the pigment in all its various shades. Very many medals were also awarded for oxides of minerals, and preparations of colours and dyes. We imported from France, in 1848, 17 cwts. of ultramarine, worth £252; in 1849, 20 cwts., worth £213; in 1850, 375 cwts., worth £3,322; in 1851, 335 cwts., worth £3,377.

[The imports of ultramarine had in 1870 reached 34,427 cwts., valued at £140,143, and of zaffres and smalts, 1,093 cwts., value, £9,983.]

VEGETABLE DYES AND COLOURS.

The next grand division of our subject embraces all the dyes and colours obtained from the Vegetable Kingdom. The bark and roots of the berberry are used in the East to dye yellow; the colour is best when boiled in ley. Some of the species of *Symplocos*, as *S. racemosa*, known as lodh about the Himalaya Mountains, and *S. tinctoria*, a native of Carolina, are used for dyeing. The scarlet flowers of the Dhak tree, *Butea frondosa*, and *B. superba*, natives of the Indian jungles, yield a beautiful dye, and furnishing a species of kino (Pulas kino) are also used for tanning. *Althea rosea*, the parent of the many beautiful varieties of hollyhock, a native of China, yields a blue colouring matter equal to indigo. Indigo of an excellent quality has been obtained in the East from a twining plant, *Gymnema tingens* or *Asclepias tingens.*

The yellow unripe fruit of *Rhamnus infectorius*, *catharticus*, and *virgatus*, known as Turkey, French, and Persian berries, is used for dyeing leather yellow. When mixed with lime and evaporated to dryness, it forms the colour called sap-green. A great quantity of yellow berries are annually shipped from Constantinople. It is a subject of surprise that the common betel-nut of the East has never been introduced for dyeing purposes. The roots of the al tree of Malabar and other parts of India, *Morinda tinctoria*, found abundant in all the Asiatic islands, are extensively used as a dyestuff for giving a scarlet colour. The colouring matter resides principally in the bark of the roots, which are long and slender, and the small pieces are the best, fetching 8*s*. to 10*s*. a maund. It is exported in large quantities from Malabar to Guzerat, and the northern parts of Hindostan, but seldom finds its way to Europe.

The wood and roots of another species, *Oldenlandia umbellata*, known in the eastern islands as "Mangkudu," are used extensively for their red dye, in Celebes and Java. Specimens of all these, and of the Lopisip bark, bunchong bulu wood, and the gaju gum (from undescribed plants), have been imported into England. They are said to furnish excellent dyes in the Asiatic islands. Native dyes from Arracan have also been introduced, viz., thit-tel and the-dam yielding red dyes, ting-nget and reros affording dark purple dyes, and thit-nan-weng a chocolate dye. These would be worth enquiring into, and particulars of the plants yielding them, the quantities available, and the prices, might be procured. Dyes and colours from the fol-

lowing plants are obtained in India: several species of *Terminalia*, *Semecarpus anacardium*, *Myrica sapida*, *Nelumbium speciosum*, and *Nyctanthes arbortristis*. The bunkita barring, obtained from an undescribed plant in Borneo, produces a dark purple or black dye. A species of *Ruellia*, under the name of "room," is employed by the Khamptes and Singphos to dye their clothes a dark blue. It is described by the late Dr. Griffiths as "a valuable dye, and highly worthy of attention." In Nepaul they use the bark of *Photinia dubia* or *Mespilus bengalensis* for dyeing scarlet. The bark of the black oak, *Quercus tinctoria* and its varieties, natives of North America, is used by dyers under the name of quercitron.

In the south of Europe, *Daphne gnidium* is employed to dye yellow. The root of reilbon, a sort of madder in Chili, dyes red. A purple tint or dye is obtained from the bark of an undescribed tree, known under the name of "Grana ponciana," growing about Quito; and Stevenson ("Travels in South America") says, "if known in Europe it would undoubtedly become an article of commerce." Another much more expensive species of colouring matter (red) is obtained in various parts of South America from the leaves of the *Bignonia chica*. Dr. Ure thinks it might probably be turned to account in the arts. The order of plants to which it belongs contains a vast number of species, all natives of tropical countries, and their value for the production of colouring substances may be worth investigation.

A beautiful bluish-black colour, known as "cauto," is procured in Demerara and Berbice from the juice of the *Genipa americana* (Linnæus)—a tree very common in

the colony. The Indians use it for staining their faces and persons. Another pigment is prepared by them from arnotto, mixed with turtle oil, or crab oil, obtained from the seeds of the *Carapa guyanensis* (Aublet). The wild plantain (*Urania guyanensis*) and the cultivated plantain (*Musa paradisiaca*), the Mahoe (*Thespesia populnea*) and the seed of the Avocado pear (*Persea gratissima*) furnish dyes in various parts of the West Indies; and specimens of some of these have been imported from British Guiana and Trinidad.*

Russia produces good specimens of the root of *Statice coriaria*, the leaves and bark of sumach, the bark of the wild pomegranate, yellow berries, *Madia sativa*, saffron, safflower, and madder roots, for dyeing purposes.

Avicenna tomentosa, a species of mangrove, is very common about the creeks of Antigua, Jamaica, and other West Indian islands, and the bark is used for tanning.

In New Zealand the natives produce a most brilliant blue-black dye from the bark of the *Ens*, which is in great abundance. Some of the borders of the native mats, of a most magnificent black, are dyed with this substance. It has been tried in New South Wales; but, as with other local dyes, although found well suited for flax, hemp, linen, or other vegetable productions, it could not be fixed on wools or animal matter. It is of great importance that chemical science should be applied to devise some means of fixing this valuable dye on wool. As the tree is so common, the bark could be had in any quantity at about £3 10*s*. a ton; and our tweed manufacturers are in great want of a black dye for their check and other cloths.

Red Sanders wood (*Pterocarpus santalinus*), which is hard, and of a bright garnet-red colour, is employed to dye a lasting reddish brown on wool. It only yields its colour to ether or alcohol. The tree, which is a lofty one, is common about Madras and other parts of India; it is also indigenous to Ceylon. The exports of this wood from Madras in one year have been nearly 2,000 tons.

The other heavy woods used for dyeing are fustic, logwood, sappan wood, camwood, barwood, peachwood, and Brazil wood.

Of fustic we import from 1,500 to 2,000 tons annually. We derive our supplies from Brazil, Tampico, Puerto Cabello, Cuba, and Jamaica. The best is obtained from Cuba; for while the common white fustic from Jamaica and the Spanish Main fetches only £4 10*s*. to £6 the ton, that of Cuba realises from £8 to £9 the ton.

Logwood is increasing rapidly in use, for whilst in 1837 we retained scarcely 15,000 tons for home use, in 1850 the quantity exceeded 30,000 tons. The wood grown in Jamaica is the least valued, that from Honduras and St. Domingo fetches a somewhat higher price; but logwood imported from Campeachy direct is the most esteemed.*

Sappan wood (*Cæsalpinia sappan*) is an article of considerable commerce in the East. It is the bukkum wood of Scinde, and is procured in Mergui, Bengal, the Tenasserim Provinces, Malabar, and Ceylon. In 1842 as much as 78,000 cwts. were shipped from

* An Article of mine "On the Trade in Logwood" will be found in "The Technologist," vol. iv, p. 328.

Ceylon, but the export from thence has decreased. A large quantity is shipped from Siam and the Philippine Islands; as much as 200,000 piculs annually from the former, and 23,000 piculs from Manilla. 3,524 piculs were shipped from Singapore in 1851, and 4,074 piculs in 1852. The picul is about 1¼ cwts. Sappan wood yields a yellowish colour, like that of Brazil wood (*C. brasiliensis*), but it does not afford so much dye matter, nor is it so good in quality.

Camwood, barwood, red sanders wood, and other dyewoods, are found in great quantities in many parts of Africa. The dyes of Africa are found to resist both acids and light—properties which no other dyes seem to possess in the same degree. About thirty miles east of Bassia Cove, in the Republic of Liberia, is the commencement of a region of unknown extent, where scarcely any tree is seen except the camwood. This boundless forest of wealth, as yet untouched, is easily accessible from that settlement; roads can be opened to it with little expense, and the neighbouring kings would probably give their co-operation to a measure so vastly beneficial to themselves. It is impossible to ascertain the exact export of these commodities to Europe and the United States, but it is very great, and employs a large amount of vessels. One Liverpool house imported 600 tons in a single year, worth about £9,000. In 1841 upwards of 3,000 tons of dyewoods were imported into Liverpool from the West Coast of Africa.

Arnotto. The plants of this family are chiefly natives of the warmest parts of South America, the East and West Indies, and Africa. In America the

seeds are called achiote or roucou. From the port of Barcelona, in Venezuela, about 2,000 quintals are annually exported. The species grown for its dye is the *Bixa orellana*. It is used to impart a bright orange colour to silk goods, and to afford a deeper shade to simple yellows. The dry, hard paste is also found to be the best of all ingredients for giving a golden tint to cheese or butter; a convenient liquid preparation is now sold to the dairymen. The Spanish Americans mix it with their chocolate, to which it gives a beautiful rich hue. The dye is usually prepared by macerating the pods in boiling water; and the subsequent process is a tedious and troublesome one. M. Leblond suggests a preferable practice, which is simply to wash the seeds till they are entirely deprived of their colour, which lies wholly on the surface; to precipitate the colour by means of acetic acid, and to boil it up in the ordinary manner, or to drain it in bags, as is practised with indigo. The arnotto prepared in this manner is found to be worth four times that of the ordinary paste of commerce; it requires less solvent, and furnishes a purer colour. Our imports of arnotto for home consumption are from 200,000 to 300,000 lbs. per annum. The plant is grown in the Deccan and other parts of India, and the Eastern Archipelago. At the Hawaiian Islands, Tongataboo, Rio Janeiro, Peru, and Zanzibar, the arnotto is an indigenous shrub.

Chay-root (*Oldenlandia umbellata*) is extensively cultivated as a dye plant in the East, especially on the coasts of Coromandel, Nellore, Masulipatam, Malabar, and other parts of India. The outer bark of the roots

furnishes the colouring matter for the durable red, for which the chintzes of India are famous. Chay-root forms a considerable article of export from Ceylon. The wild plant there is considered preferable, yielding one-fourth more colouring matter, and the right to dig it is farmed out. It grows spontaneously on light, dry, sandy ground on the sea coasts. The dye is said to have been tried in Europe, but not with very advantageous effect. Dr. Bancroft suspects it may be injured by the long voyage, but he adds that it can produce no effect which may not be more cheaply obtained from madder.*

Indigo. The plants which afford this dyestuff grow chiefly in the East and West Indies, in the middle regions of America, in Africa, and Europe. They are all species of the genera *Indigofera*, *Isatis* and *Nerium*.

Indigofera tinctoria furnishes the chief indigo of commerce, and affords in Bengal, Malabar, &c., an article of middling quality. Roxburgh stated that he extracted most beautiful light indigo from the *I. cærulea*, and in greater quantities than he ever procured from the common indigo plant. The *I. disperma*, cultivated in the East Indies and America, grows higher than the preceding, and yields a superior dyestuff; the Guatemala indigo comes from this species. *I. anil* grows in the same countries, and also in the

* Some excellent descriptive papers "On the Dyestuffs of India," by Mr. M. C. Cooke, were published in my periodical, "The Technologist," in 1862, "On the Yellow Dyestuffs," vol. i, p. 1; "On the Red Dyestuffs," p. 65; "On the Blue Dyestuffs," p. 121; and a final paper at p. 132.

West Indies. *I. argentea*, which grows in Africa, yields little dyestuff, but it is of an excellent quality. *I. glaucescens* is also an Egyptian and Arabian species. The *Wrightia tinctoria* of the East Indies affords some indigo, as does the *Isatis tinctoria*, or woad, in Europe, and the *Polygonum tinctorium*, a native of China. *Baptisia tinctoria*, the wild indigo of the United States, also furnishes a blue dye.

Indigo is at present grown for the purposes of commerce in Bengal and the other provinces of that Presidency, from the twentieth to the thirtieth degrees of north latitude; in the province of Tinnevelly, Madras Presidency, in the largest of the Philippine Islands, in Guatemala and Venezuela, Central America and Brazil. It is also produced in some of the West India Islands, especially St. Domingo, but not in large quantities. Bengal is the chief mart for it, and the quantity of indigo made in other places is comparatively inconsiderable. The average production of indigo in India for the two years ending 1849 was 126,744 maunds (of about 74lbs.), of which nearly 85,000 were from Bengal alone. In July the plants are cut when in blossom, that being the time when there is the greatest abundance of dyeing matter. The plant is then steeped in a vat till it has become macerated and parted with its colouring matter, then the liquor is let off into another vat, in which it undergoes a peculiar process of beating, to cause the fecula to separate from the water; the fecula is then let off into a third vat, where it remains some time, and is then strained through cloth bags, and evaporated in shallow wooden boxes placed in the shade. Before

it is perfectly dry, it is cut into small pieces an inch square; it is then packed up for sale. It is generally divided into two classes—Bengal and Oude. Madras indigo is not much inferior to that from Bengal. The best indigo comes from the districts of Kishnagur, Jeypore, Moorshedabad, and Tirhoot. Some of a very fine quality is made in Scinde. Indigo grows wild in several parts of Palestine, but attention seems not to have been given to its cultivation or collection. In our settlements of Honduras, Demerara, and other portions of the American continent, it would amply reward the labour of the cultivator; several inferior species of *Indigofera* being found there indigenous, and only requiring care and culture to improve them.

The indigo imported from the Western hemisphere was for some time considered superior in quality to that of the East. Its cultivation, however, has been neglected, and the Bengal indigo is preferred at present to any imported from South America, where it is now only cultivated by the Brazilians and Colombians. If proper attention were paid by the latter to the cultivation of this plant, and to the preparation of the dye, it is very likely that part of this important trade would be regained. It thrives best in a moist climate, and the interior of Trinidad and Guiana, chiefly newly-cleared land, would be well adapted for it. The cultivation has been repeatedly attempted in Cuba, but never with much success, although the shrub from which it is extracted grows wild in several districts of the island. The indigo is one of the most common bushes in Trinidad, where it grows wild on almost all the ordinary soils. Several plantations were established

towards the close of the last century, but were abandoned on the supposition that the manufacture was unhealthy. Indigo was once a most important crop in South Carolina, and some attention has recently been given to it by an individual or two in Louisiana, and the enterprise is said to promise success. Enough might undoubtedly be raised in the United States to supply the home market. Indigo to the extent of 220,000 lbs. per annum is now grown in Egypt. Many Armenians have been invited from the East Indies to teach the fellahs the best modes of preparation, and, in consequence, nine indigo works have been established, belonging to the Government. On most parts of the eastern and western coasts of Africa it is indigenous; at Sierra Leone, Liberia, and the Cape Colony it is abundant. The plant is found scattered like a weed over the face of the country in the colony of Natal; it is said that there are no less than ten varieties commonly to be met with there. Mr. Blaine, in 1848, submitted to the Manchester Chamber of Commerce a small specimen of the dyestuff which had been extracted by a rude process from a native plant, which was pronounced by good authority to be of superior quality and worth 3*s*. 4*d*. per lb. Mr. W. Wilson, another settler there, who has turned his attention to the cultivation, obtained in the proportion of 300 lbs. of indigo to the acre.

In Java the culture has made rapid progress; the exports now reach nearly 2,000,000 lbs. annually. [This has fallen off.] A large quantity is raised in the Philippine Islands, nearly 8,000 cwts. having been exported in 1847. Indigo grows wild in Siam, and all

the blue dye used in that country is manufactured from this plant. The extensive low grounds are admirably suited for its extended culture. Indigo, although indigenous in Ceylon, is still imported for local supply from the neighbouring continent. Its growth in that island would be subject to none of the vicissitudes of climate that in the course of a single night have devastated the most extensive plantations in Bengal, and annihilated the hopes and calculations of the planters, at a time when they had attained all the luxuriance of approaching maturity.

In 1790 the general object of cultivation in the Mauritius was indigo, of which from four to five crops a year was procured. One person sent to Europe, in 1789, 30,000 lbs. of a very superior quality. It has long since given place to sugar as a staple. In the year 1852 we imported 70,500 cwts. of indigo, of which about 16,300 cwts. were retained for home consumption.

Madder. This article, so extensively used as a red dye, is the product of the long slender roots of the *Rubia tinctorum* and allied species, a plant of which there are several varieties. Our supplies of this important article of commerce are obtained from several of the continental countries of Europe, India, and Ceylon. About 1,100 tons are annually shipped from Naples, worth about £30 the ton. It is extensively grown on the central table-land of Affghanistan, and is one of the leading products of Beloochistan, and according to Mr. Pottinger it sells in the Kelat bazaar at about 10 lbs. for 2*s*. A cultivator in Ohio, United States, has found it a most profitable crop; he raises

2,000 lbs. per acre, with very little labour or expense. Our imports are enormous; in one year they have consisted of 261,841 cwts., all of which was for home consumption.*

Indian madder is obtained from *Rubia munjista* and *R. cordifolia*. It is cultivated chiefly about Assam, Nepaul and Scinde, Bombay, Quitta, and also in China. Its dyestuff is known in commerce as munjeet; 525 tons of it were imported into Liverpool in 1850.

A considerable portion of the madder roots, instead of being ground and exported in that form, as heretofore, is now exposed, after being invested with dilute sulphuric acid, to a boiling heat by means of steam, by which the colouring matter is considerably altered and improved in quality for some dyeing processes, while the quantity rendered soluble in water is greatly increased. The madder so prepared is known as garancine, and forms an important branch of manufacture in the South of France, which was well illustrated at the Great Exhibition in 1851 by a collection of specimens supplied by the Chamber of Commerce of Avignon. The spent madder, after being used in dyeing, is now also converted by Mr. H. Steiner, of Accrington, into a garancine (termed *garanceuse* by the French) by steaming it with sulphuric acid in the same manner as the fresh madder, and thus a considerable quantity of colouring matter is recovered and made available which was formerly thrown away in the spent madder. Both varieties of garancine give

* See an Article "On the Trade in Madder" in "The Technologist," vol. i, p. 151.

a more scarlety red than the unprepared madder, and also good chocolate and black, without soiling the white ground, but are not so well fitted—particularly the garancine of spent madder—for dyeing purples, lilacs and pinks. The value of the garancine imported from France in 1848 was £59,554, the value of that imported in 1851 was £93,818. The greatly increased imports of late years are shown in the appended table:—

IMPORTS OF DYEWOODS AND DYESTUFFS.

		1867.	1868.	1869.	1870.
Brazil Wood	tons	576	2,300	7,357	3,215
Logwood	„	28,530	35,468	50,458	62,187
Fustic	„	9,414	11,524	12,446	10,657
Sappan Wood	„	1,489	3,143	3,400	2,066
Quercitron Bark	cwts.	28,608	56,079	54,121	44,452
Gamboge	„	175	515	481	449
Cochineal	„	41,325	31,138	32,002	36,672
Indigo	„	71,995	75,874	86,721	79,255
Madder and Madder Root	„	259,501	306,723	143,765	173,318
Garancine	„	66,468	79,612	30,510	42,195
Sumach	tons	13,440	13,251	13,234	14,431
Gambier	„	13,237	20,239	16,267	19,050
Cutch	„	2,111	3,541	2,573	5,946
Valonia	„	19,547	29,623	23,652	25,718
Myrobalans	cwts.	64,273	137,812	251,953	56,610
Yellow Berries	„	8,576	9,621	9,570	8,580
Bark for Tanning or Dyeing	„	476,105	408,212	461,540	448,746
Extract of ditto	„	28,622	42,443	31,026	15,137
Galls	„	18,565	23,842	21,040	11,748
Lac Dye	„	9,260	11,441	14,275	14,131
Shellac	„	31,633	30,589	46,180	31,912
Munjeet	„	360	1,145	3,921	2,749
Orchil	„	24,443	19,379	38,599	41,899
Safflower	„	9,319	32,532	9,544	14,597
Saffron	lbs.	9,401	26,048	22,152	43,950
Turmeric	cwts.	1,841	2,183	3,214	2,245
Ultramarine	„	25,784	32,747	32,065	34,427

Re-exports from the United Kingdom.

		1867.	1868.	1869.	1870.
Coçhineal	cwts.	23,727	21,327	24,243	22,620
Indigo	„	62,692	60,891	60,821	46,279
Sumach	tons	1,679	533	252	395
Gambier	„	4,655	4,792	5,767	3,935
Cutch	„	1,455	2,312	2,549	2,115
Shellac	cwts.	26,660	24,747	27,505	19,812

Computed Real Value of the Dyewoods, Dyestuffs, and Tanning Barks, &c., Imported in 1869 and 1870.

Dyewoods.	£	£
Barwood and Camwood	28,176	13,178
Braziletto	76	12
Brazil Wood	83,815	35,365
Fustic	12,446	58,339
Green Ebony	1,073	2,422
Logwood	50,458	294,119
Nicaragua	17,408	15,824
Red Sanders	19,791	34,428
Red Wood, or Guinea Wood	4,493	659
Sappan Wood	3,400	15,222
Unenumerated	15,977	11,248
Total	£237,113	£480,816

Other Dyestuffs, &c.		
Arnotto, Roll and Flag	30,788	25,420
Barks for Tanning or Dyeing	157,935	149,493
„ Extract of do.	36,045	32,671
„ Quercitron	24,843	16,391
Carmine	1,032	1,542
Cochineal, Granilla, and Dust	579,547	581,956
Carried forward	£1,067,303	£1,288,299

Brought forward	£1,067,303	...	1,288,299
Divi-divi	44,014	...	15,830
Dragon's Blood	......	...	1,557
Dyestuffs, Unenumerated	50,054	...	59,159
Galls	75,034	...	54,169
Gambier and Cutch	360,399	...	468,388
Gamboge	7,177	...	6,493
Garancine	202,372	...	275,177
Indigo	3,194,613	...	2,721,208
Lac Dye and Shellac	282,251	...	250,371
Madder and Madder Root	416,266	...	428,545
Munjeet	7,151	...	3,471
Myrobalans	138,543	...	32,928
Orchil	101,239	...	112,693
Rock Moss, for Dyeing	216	...	71
Safflower	106,547	...	168,536
" Extract of	1,064	...	1,759
Saffron	36,596	...	95,690
Seed Lac, and Stick Lac	23,662	...	7,498
Smalts	8,848	...	9,623
Sumach	201,615	...	228,431
Turmeric	65,218	...	44,639
Ultramarine	130,719	...	140,143
Valonia	357,455	...	395,546
Yellow Berries	55,121	...	51,516
Total	£6,933,478		£6,863,859

Safflower. The dried flowers of *Carthamus tinctorius* yield a pink dye; the colour, however, is very fugitive. The plant is cultivated in China, India, Egypt, America, and some of the warmer parts of Europe; and is indigenous to the whole of the Indian Archipelago. A large quantity is grown in and exported from Bali. In Egypt it forms a considerable article of commerce. The Chinese safflower is considered the best, and that from Bombay is least

esteemed. The annual quantity exported from the district of Dacca averages about 150 tons. The shipments from Calcutta exceed 300 tons to various quarters. Our imports are on the decline, and are now only about 1,200 cwts. per annum. Safflower was shown in the Exhibition from Celebes, Assam, the vicinity of Calcutta, Dacca, Rajpootana, and other places.

Sumach, sometimes called young fustic, is the pulverised leaves and young shoots of *Rhus coriaria*, a small deciduous tree, native of the south of Europe, the Ionian Islands, and the Morea. It possesses powerful astringent properties, which render it valuable for tanning light-coloured leathers; and it imparts a bright yellow dye to cottons, which is rendered permanent by proper mordants, the species grown for the purpose in Spain, Portugal, and Italy, is *Rhus Cotinus*. In Montpelier and the South of France the twigs and leaves are known under the name of *rédoul* or *roudo*. They are gathered every year, and the shoots are chipped and reduced to powder by a mill. From Sicily the exports are very large; in 1842 they were 123,305 tons, valued at nearly £69,000. In 1841 we received about 9,000 tons from the port of Leghorn. We annually import about 13,000 or 14,000 tons for home consumption.†

Myrobalans. Under this name a dried fruit of the plum kind is imported from the East Indies for dyeing and tanning purposes. It is the produce of *Terminalia chebula*. The unripe fruit varies from the size of an

† See my Article "On the Culture and Trade in Sumach," in "The Technologist," vol. iv, p. 324.

olive to that of large gall nuts. It is highly valued by dyers, creating, when mixed with alum, a durable dark brown yellow colour. The bark and leaves of *T. catappa* yield a black pigment, with which Indian ink is made. The annual import of myrobalans is very large. They come principally from Calcutta and Bombay; but a few tons are occasionally shipped from Ceylon.*

TABLE SHOWING THE COMPARATIVE IMPORTS OF THE LEADING DYESTUFFS, &c. IN THE LAST 30 YEARS.

	1840.	1845.	1850.	1855.	1860.	1865.	1870.
Cochineal .... cwts.	9890	9808	22451	27957	23430	26910	36672
Gambier and Cutch .... tons	3483	7629	5757	7683	11718	15708	24996
Garancine .... cwts.	..	3743	6133	26066	38344	33571	42195
Indigo .... ,,	65029	90424	70428	59760	77321	66506	79255
Madder and Madder Root ,,	250210	215047	261860	275297	283295	237352	173318
Sumach .... tons.	9351	11398	12929	13062	13993	13045	14431
Valonia .... ,,	8199	19078	12526	10838	18856	19702	25781

Terra Japonica is the misapplied commercial name of the dyestuff obtained from the gambier plant (*Uncaria gambir*, Roxburgh; *Nauclea gambir*, Hunter), of which 25,000 tons are now annually imported. The cultivation is carried on almost entirely in the island of Singapore, where it is generally grown in connection with pepper. Gambier, being one of the most powerful of the pure astringents, is very valuable to the tanner. The commercial

* An Article of mine "On the Myrobalans of Commerce" will be found in "The Technologist," vol. ii, p. 184, and some further notes on them in vol. iii, p. 470.

product is obtained either by decoction or infusion of the leaves, and subsequent inspissation. The culture of gambier is making rapid progress in Java; nearly 4,000 tons were exported thence so long ago as 1843.

Gamboge scarcely merits the name of a dyestuff, but is extensively used as a pigment, from its bright yellow colour. True gamboge, by whatever name it enters into commerce, whether as from Ceylon, India or Siam, is now stated to be the product of one species of plant, the *Garcinia morella*, Desr. The variety *sessilis* of this plant yields the Ceylon and Indian gamboge, and the variety *pedicellata* the Siam gamboge. This latter description alone enters into European commerce, and is used in medicine and the arts.

In the month of June or July, when the sap is in active circulation, the leaves and young branches are broken off, and the yellow juice that flows from the wounds is collected in cocoa-nut shells or twisted leaves of the plant itself; it is afterwards poured into larger vessels made of clay, and dried in the sun until it is of proper consistence to be wrapped in leaves. From this mode of obtaining it, it received the name by which it is sometimes known of *gummi guttæ*. The method employed by the Malays and Chinese to give it the qualities sought for in commerce is unknown. After its purification it is agglomerated into irregular masses or cakes, and wrapped in leaves, or poured into bamboos, of which it retains the shape. It is sometimes met with in the English market still enclosed in bamboos. In Ceylon it is obtained by cutting the bark of the tree in several places with a sharp stone just as the flowers commence to appear; the juice

which flows solidifies in the sun. Sometimes a slip of bark the size of the hand is removed: this is done in the morning. The gamboge oozes through the pores in nearly a liquid state, but soon thickens, and is collected the following morning. The tree is not injured by the wound, which heals rapidly. The *resin* or *gambogic acid* is obtained by evaporating to dryness the ethereal tincture of gamboge. It is friable, of an orange-yellow colour, insoluble in water, soluble in alcohol, and especially in ether, and forms salts with alkalies. Several other plants, as the *Garcinia cambogia,* Desvr. and the *Vismia cayennensis,* yield a similar yellow viscid exudation hardly distinguishable from gamboge, and used for the same purpose by painters. The *Garcinia elliptica,* Wallich, of Tavoy and Moulmein, affords gamboge, and approaches very closely in its character to Graham's *Hebradendron.* In like manner the Mysore tree bears an exceedingly close resemblance to that species. It is common in the forests of Wynaad in the western part of Mysore, and has been named by Dr. Christian *Hebradendron pictorium.* Another gamboge tree has recently been found inhabiting the western Burmese territories. Both these seem to furnish an equally fine pigment. As it can be obtained in unlimited quantity, it might be introduced into European trade, once the natives learn how to collect it in a state of purity, and make it up in homogeneous masses in imitation of pipe gamboge, the finest Siam variety. It seems to possess more colouring matter, more resin and less gum than the ordinary gamboge of commerce.* Gamboge owes its

colour to the fatty acid. The resin must be regarded as the chief constituent, and is most abundant in that imported from Ceylon, which contains about 76 per cent., and is, therefore, best adapted for painting.

Turmeric, the branches of the rhizome, or root-stock of the *Curcuma longa* and *C. rotunda*, are employed in dyeing yellow, principally silks, but the colour is very fugitive. As a condiment it enters into the composition of curry sauce and powder. It is grown in and exported chiefly from Bengal and Malabar, Madras, Java, and China. The common long turmeric has been found wild in Jamaica, growing luxuriantly on the mountainous districts on the north side of the island, and in the last century it was an article of export, as Dallas mentions the shipment of 397 bags of turmeric from thence, in 1797. The best Bengal, Madras, and Malabar turmeric fetches 12*s*. to 18*s*. per cwt., half the price of ginger, and there is no reason why the West India planter could not send it to the British market quite as cheap as the East India trader. It is much cultivated about Calcutta, and all parts of Bengal, where an acre yields about 2,000 lbs. of the fresh root; it is also grown about the city of Patna and Behar, and on the central table-land of Affghanistan; the quantity shipped from Madras, in 1850, was 6,877 bags. In China turmeric is used with Prussian blue for colouring and facing teas. Upwards of 3,000 cwts. are sometimes imported here in a year.

Various species of *Lecanora*, particularly *L. tartarea*, known as cudbear, are used in dyeing woollen yarn. The *Roccella tinctoria* and *fusiformis* furnish the orchil, of orchella weed of commerce, which is sometimes sold

as a moist pulp, but usually in the form of dry cakes, known under the name of *litmus*; it produces a fine purple colour. Our imports, which amounted in 1870 to nearly 42,000 cwts., are derived chiefly from the Canary, Azores, and Cape Verd Islands. Orchella weed is very plentiful about the shores of the islands of New Zealand; some was sent from thence to the London Exhibition of 1851; but from a want of knowledge as to the time at which it should be gathered, and the mode of preparing it for the market, it has not yet become a saleable commodity here. The rich varieties of lichens on the rocks and plains of Australia have not been tested as they ought to be with Hillot's lichen test. Various lichens, among others *Roccella tinctoria*, from Tenasserim and other parts of India, have been introduced. In the Admiralty instructions given to Captain Sir James C. Ross, on his Antarctic voyage, his attention was specially called to the search and enquiry for substitutes for the *Roccella*, which is now becoming scarce.

The beauty of the dyes given by common materials in the Highlands of Scotland to some of the cloths which were exhibited, should lead our botanists and chemists to examine, more closely than they have hitherto done, the dyestuffs that might be extracted from British plants. Woad (*Isatis tinctoria*) and the dyers' yellow weed (*Reseda luteola*) are both well known. A piece of tweed, spun and woven in Ross-shire, was dyed brown and black, by moss and alder bark, and the colours were unexceptionable.

Sutherlandshire tweed and stockings, possessing a

rich brown colour, were produced with no more valuable dye than soot; in another piece, beautifully dyed, the yellow was obtained from stony-rag, brown was obtained from the crops of young heather, and purple from the same, but subjecting the yarn to a greater action of the dye than was necessary to produce a brown. There is very little doubt but that beautiful and permanent dyes, from brown to a very rich purple, might be cheaply procured by scientific preparations of the common heather (*Genista tinctoria*). The inhabitants of Skye exhibited cloth with a peculiarly rich dye, obtained from the "crottal" moss. In the Spanish department, specimens of vegetable dyes from many cultivated and wild plants were furnished by the Agricultural Board of Saragossa, and of several of these it would be important to obtain descriptions and particulars.

THE MANUFACTURE OF AND TRADE IN PRECIOUS METALS AND FANCY ARTICLES.*

WE furnish some statistics of the numbers engaged in the watch, jewellery, cutlery, and allied trades, as far as ascertainable, and the value of the goods dealt in, as shown by the import and export trade. We have some certain data in official returns to compile from, but in other branches we must either assume figures or leave the matter open to private estimate or conjecture.

We will take the classified trades in the following order:—1. Watch and Clock Making Trades. 2. Goldsmiths and Jewellers. 3. Electro-Plate. 4. General Fancy Trade. 5. Opticians and Philosophical Instrument Makers. 6. Cutlery. 7. Vulcanite, Ivory, Pearl, Horn, and Bone. 8. Bullion Brokers, Money Changers and Assayers.

1. In the Watch Making Trade in London there are about 1,400 master tradesmen of various kinds,

* Published as a Preface to "The Post Office Directory of the Watch and Clock Trades, Goldsmiths and Jewellers, the Precious Metals, Electro-Plate, and General Fancy Trades, throughout England, Scotland, and Wales." Kelly and Co., 1872.

exclusive of jobbing workmen not having a fixed address. There are, however, about four times that number in the United Kingdom. The Clock Makers are one of the old Livery Companies of London. There are 6 clock factories in the United Kingdom which employ steam power.

Of the import trade in clocks and watches, we have full details. For instance, there were imported in 1869 and 1870 :—

1869.

Gold Watches, 30,735, valued at	....	£86,236
Silver Watches, 98,977 „	....	112,971
Clocks, 330,412 „	....	319,008
	Total.........	£518,215

1870.

Gold Watches, 42,798, valued at	....	£142,220
Silver Watches, 180,339 „	....	230,200
Clocks, 256,861 „	....	258,628
	Total.........	£631,048

There are, probably, 30,000 gold watch-cases hall-marked annually in London, and half that number at the Assay Offices in the provinces; 100,000 silver watch-cases are marked in London, and half that number in the provinces.

2. The Goldsmiths and Jewellers form a large and influential class of the trading community. There are about 50 workshops in the kingdom using steam power, and in which upwards of 2,000 persons are

employed. A recent writer well observes, "At no period in the world's history could the yearly produce of the precious metals have been compared with what it has become in recent times. The number of goldsmiths, and the extent of the business they severally command, have both increased. Factories have arisen where formerly only the benches of single artificers were needed; and machinery now lightens the labour of the gold-beater, the wire-drawer, the embosser, and the engraver, and performs processes once most toilsome with a rapidity and perfection which hand-work could never have approached. Articles in gold and silver, cheaper and of finer workmanship, are thus produced, the demand for them is stimulated, and the number of artificers employed is greatly increased." The uses of gold are very numerous; alloyed with copper or silver, it is employed for coin, plate, and a variety of articles of luxury and ornament, for which purposes it is in the highest request, from its great beauty, unchangeableness, and lustre. In the arts it is extensively used for gilding. Since the large discoveries of gold in California, Australia, New Zealand, and other quarters, at least £500,000,000 sterling of gold have been added to the previous stock in circulation in the world. The value of the gold coined at the British Mint in the fifteen years ending 1854 was £65,634,328, and in the fifteen years ending 1869, £76,397,545, so that an average of more than £4,500,000 worth of new gold coin is annually put into circulation in the United Kingdom, exclusive of what is used in the arts and manufactures. There is a balance of gold

remaining in the country, as shown between the official imports and exports in the last fifteen years, of about £118,000,000:—

IMPORTS OF GOLD BULLION AND SPECIE.

Five years ending	1855	£85,100,000
„	1860	100,316,508
„	1865	82,596,827
„	1870	89,023,517
	Total	£357,036,852

EXPORTS OF GOLD BULLION AND SPECIE.

Five years, ending	1855	£49,453,024
„	1860	73,389,556
„	1865	64,326,685
„	1870	51,826,617
	Total	£238,995,882

By the Census of 1861 there were nearly 9,000 gold and silver workers in the metropolis (and the increase in wealth and in population will show, under the recent census taken, even larger numbers). Of these, 5,000 were gold and silver smiths and jewellers.

Silver is employed throughout the world for coins, alloyed with copper, and in the manufacture of a variety of articles of household use and ornament, for which purpose it is well adapted by its great unalterability. In the arts it is extensively used,

* The export of British coin from 1858 to 1871, was 14,907,678 ozs.; and of bullion and foreign coin, 32,336,418 ozs.; but in the same period we re-imported 6,628,200 ozs. of British coin.

particularly for silvering or plating other metals. There used to be an export of about £6,000,000 or £8,000,000 worth of silver annually to India, to compensate the wear and tear of 4 per cent. on the silver circulation in India (calculated to amount to £400,000,000), and to meet the balance of trade with China, where silver is also the circulating medium; but this export has been lessening considerably of late years.

About 50,000 ozs. of gold and 400,000 ozs. of silver pass annually through the Assay Office, and many more thousand ounces of the precious metals are worked up into small ornaments not subject to duty.

The value of the plated wares exported in 1869 was £139,222, and of gold and silver plate, £67,671, while the value of the gold and silver plate and plated ware imported was £25,919. The number of persons licensed to sell gold and silver plate in the United Kingdom is 9,521; the average duty paid to the Excise on gold and silver plate manufactured is about £60,000 per annum. The duty on gold plate stamped is 17*s.* per oz., and on silver plate, 1*s.* 6*d.* per oz.

3. The Electro-Plate Trade principally centres in Birmingham and Sheffield, but there are, nevertheless, 2,500 gilders and platers in the metropolis, and about 100 factories in the provinces employing 7,000 hands. The value of the plated wares annually manufactured is estimated at £1,500,000—this department having derived great advantage from the perfection of the machinery now used in this country for rolling metals, while it has, no doubt, likewise received encouragement from the heavy duties imposed on gold and

silver articles. The improvement that has been made in the manufacture of plated wares has had a great influence in diminishing the sale of real plate, although it may have led to an increased consumption of the precious metals.

There are no means for obtaining correct returns of the quantities of gold and silver annually consumed in the manufacture of gold and silver wares in the United Kingdom. It must, however, be very considerable, as articles of precious metals are produced in almost all large towns. It has been ascertained that not less than 1,000 ozs. of pure gold are used weekly in Birmingham, and that the consumption of gold leaf in eight manufacturing towns is equal to 600 ozs. weekly. For gilding metals by electrotype and the water gilding processes, not less than 10,000 ozs. of gold are required annually.

4. The General Fancy Trade comprises the sale of a large number of articles, some of which centre a good deal in what are called bazaars, whilst others are sold in stationers', perfumers', and other shops. It includes all such articles as small bronzes, work-boxes, desks, dressing-cases, envelope and writing-cases, ladies' bags. Lastly, musical boxes may come under the fancy trade sales ; of these, 5,024, valued at £19,956, were imported in 1869, chiefly from France.

5. Of the number of actual Makers of Optical and Scientific Instruments it is difficult to form an exact estimate. There are in London alone 475. If we consider the variety of articles made, viz.:—Spectacles, eye-glasses, barometers, thermometers, surveying and mathematical instruments, microscopes, telescopes, &c., the number of persons engaged must be considerable.

There are 18 mathematical instrument factories in which steam power is employed. Of opera glasses we imported 41,000 from France in 1869, and 26,729 in 1870. The Spectacle Makers' Company is still kept up as one of the Livery Companies of London.

6. Cutlery. Twenty years ago it was estimated that upwards of 400,000 persons were employed directly in the hardware and cutlery manufactures in England, and the aggregate value of such goods produced annually exceeded £20,000,000.* But, with improvements in the metal trades, the increase of population, and the extension of our commerce, this sum must now be largely below the mark, for our exports in these items have increased since then 50 per cent. Hardware is a term employed to denote every description of metals when manufactured into articles of use. Cutlery is the term used to designate all kinds of sharp cutting instruments, such as table knives and forks, razors, scissors, swords, penknives, surgical instruments, &c. The great seat of manufacture is Sheffield, the trade being under the control of the Cutlers' Company—as that of the metropolis used to be under the Cutlers' Company of London. About 3,000 operatives are employed in forging and grinding the blades of table knives; an equal number of workpeople are engaged on pen and pocket knives, made annually to the value of about £100,000; very many are occupied in fabricating razors and scissors.

7. The value of the Rubber and Vulcanite Trade can only be guessed at, but combs, jewellery, and other articles are extensively made from it; and there

* Braithwaite Poole's "Statistics of British Commerce."

are more than a dozen large companies and firms engaged in the manufacture, whose transactions are on a very extensive scale. The value of the india-rubber imported annually is stated at over £1,600,000 sterling, and this first cost would certainly be doubled in manufacture. All this, it is true, cannot be set down to fancy articles, but comprises telegraph wire, wearing apparel, and articles of general utility made of the elastic gums. Thus caoutchouc manufactures of the value of £693,012 were exported in 1870.

Ivory, of which we imported 14,600 cwts. in 1869, of the value of £507,319, is principally used for fancy articles, ivory carvings, knife and brush handles, billiard balls, chessmen, &c. Sheffield consumes annually more than 70 tons for the handles of knives and forks.

The vegetable ivory nut is also turned into a number of fancy articles. The value of the raw material—31,430 cwts. of corosso nuts—imported in 1870, was given at £19,886. Every one of these nuts is made into some little fancy article, selling at from *4d.* to *6d.* Coquilla and other nuts are also used for turning and carving to about the same value.*

Mother-of-pearl shell enters largely into manufacturing trade for various fancy articles. The imports in 1869 were 37,662 cwts., valued at £94,015, and in 1870 rather less.

Tortoise-shell and turtle-shell, for comb-making, inlaying, and other purposes, was imported in 1869 to the extent of 56,705 lbs., of the value of £36,596.

* See my Paper "On Nuts, their Products and Uses," read before the Society of Arts, April 24th, 1872, and published in this work. See p. 583.

Of buffalo, deer, and other unenumerated horns, &c., 5,489 tons, of the value of £172,037, were imported, besides the horns used of slaughtered cattle and deer obtained in the United Kingdom. Horn is not so much used for knife handles and buttons as formerly, but it is still largely employed for combs.

8. Bullion and Specie. The import and export trade in bullion and specie is very large, and gives occupation to twenty-nine bullion dealers and eleven bullion brokers in the metropolis, and others at some of the large outports, besides many money-changers, assayers, &c.

There are several firms of private assayers who are well skilled in estimating the value of the precious metals, and whose reports are considered reliable.

There are Assay Offices at the following provincial towns, besides the Hall of the Goldsmiths' Company, London :—Birmingham, Chester, Sheffield, Exeter, York, Newcastle-on-Tyne, Glasgow, Dublin. There are special hall and standard marks to each of these localities.

	Hall Marks.	Standard Marks.
Birmingham	An Anchor	A Lion passant.
Chester	Three Wheatsheafs and a Dagger	” ”
Sheffield	A Crown	” ”
Exeter	A Castle with two Wings	” ”
York	Five Lions and a Cross	” ”
Newcastle-on-Tyne	Three Castles	” ”
Edinburgh	A Castle and Lion	A Thistle.
Glasgow	A Tree and Salmon with a ring in its mouth	A Lion rampant.
Dublin	A Harp and figure of Britannia	A Harp crowned.
London	A Leopard's Head	A Lion passant.

Articles of all standards capable of bearing a stamp are marked with the arms and marks of the particular assay office, and a letter for the date of the year. Different kinds of letters are used by the Goldsmiths' Company; the one now employed is the old black letter. The alphabet was begun in 1856, 𝕽 being the letter for the year 1872. It runs on to twenty letters, J being omitted; a fresh alphabet is then again commenced. 22 carats fine is the legal assay mark for gold. Gold of 18 carats fine bears the mark of the Crown; silver of the new standard, 11 ozs.·10 dwts. fine, the figure of Britannia.

[In olden times the precious metals were supposed to lurk in the unknown caverns of the North. The mountains of Greenland had likewise the credit of being rich in gold, for in the book of Job, ch. xxxvii., v. 22, it is written, "Gold cometh out of the North;" and Theophrastus Paracelsus has assured us of wealthier mines in that quarter than in the East. Martin Frobisher brought home a kind of black stone that contained a considerable quantity of gold. John Knight, in 1605, likewise found metallic stones which yielded 26 ozs. of silver in 1 cwt. Their beauty and facility of working, and their capability of resisting change, are of so high an order as to constitute gold the most useful of all metals, and silver the next. Iron, though not a precious metal, is, nevertheless, to all civilised countries, a most invaluable one; while on the other hand the comparative scarcity of gold and silver in the crust of the globe causes them to be but little used for purposes of mere utility. Gold, however, is amongst the most widely disseminated of all the metals that are used in the arts,

being more ubiquitous than any metal except iron. There is hardly a country in which gold has not been found. America, independent of the alluvial soils and quartzose rocks of California, contains gold in various places; and even Canada and Nova Scotia have been found to possess deposits of this widely-diffused metal. The continent of Africa also furnishes it from its Gold Coast, and, among other districts, from a part opposite Madagascar, supposed by some to be the Ophir of old. It seems to be more common, however, between the thirtieth and fiftieth degrees of latitude on either side of the equator. In the Northern hemisphere a nearly straight line covers the Siberian, the Californian, and the Canadian diggings; another straight line, round the other half of the globe, will cover the African, the South American, and the Australian gold fields. Wherever quartz veins, traversing a black slaty rock, are to be found, there gold may be obtained either by washing out the gravel of the rivers in the neighbourhood, or by crushing the quartz, from which the particles contained in the river sands have been washed out. Gold-bearing veins, rare in the newer or rocks of the secondary and tertiary formations, are common to the primary rocks, and wherever such rocks occur, altered by volcanic action, the discovery of gold is almost certain. The volcanic action volatilises the metal, pouring it into every crack or fissure of quartz running through the rock. It has been, in fact, ascertained that these veins may be profitably rich in gold, though the particles are too small to be discerned by the naked eye. We cannot admit that we expect to see a time when our tea-kettles and fire-irons will be made of gold. We know the respect that is due to

the opinions of those who anticipate such things; but still we must humbly demur to their reasoning, and candidly confess that we shall be surprised if shovels cease to be made of iron, and latch-keys of copper or brass. Call them "baser" metals, as we will, they have their peculiar merits, and, in their proper sphere are decidedly preferable to gold. Whether, as some pretend, the increasing supplies of the precious metals will so alter the prices of gold, silver, iron, copper, lead, &c., that the latter, instead of the former, will become the standard of value;—whether iron or copper are destined to promotion in the list of minerals, while "gold dust" becomes a drug in the market, or whether the demand for the raw material at the mints will continue for an indefinite period to exhaust the supply as heretofore, are very different matters. It is hard to reconcile oneself to the idea that gold will go out of fashion—still harder that silver, iron, copper or lead will come in. It requires a bold imagination to fancy a Regent Street dandy wearing a tenpenny nail as a breastpin, or a fashionable belle with leaden rings or a copper bracelet. Such plagiarisms from our friends the Choctaws rather shock our notions. The following prophecy, however, has not yet been fulfilled, although gold is obtained somewhat too easily in distant lands. It is by Dr. Girianger, of Gottingen, and was published in the sixth volume of the "Philosophical Magazine:"—"In the nineteenth century the transmutation of metals will be generally known and practised. Every chemist and every artist will *make gold.* Kitchen utensils will be made of silver, and even gold, which will contribute more than anything else to prolong life, poisoned at present by the oxides of copper,

lead, and iron, which we daily swallow with our food." Some of us may perchance live to see whether the worthy doctor's prophecy be realised. At all events gold is becoming wretchedly common now-a-days, when people find it by the cwt., and there has been exhumed in twenty years gold to the value of £500,000,000 sterling from the gold fields of the regions of California, Australia, New Zealand, and other quarters. As our stores of silver have not increased so rapidly, science has endeavoured to find a substitute. From the simple earth of our land, from the clay of the field, has recently been compounded a new metal, aluminium, which, from its chemical properties, is in many respects superior to silver, being less liable to tarnish, quite as durable, and resisting acids. Its weight is only one fourth that of silver, and articles in aluminium can be made for one-third the cost of silver. The result of the experiments which have been made on the chlorides opens up a large field for the reduction and manufacture of other metals into articles of utility and ornament.

A cubic inch of gold is worth (at £3 17*s.* 10½*d.* per oz.), £42; a cubic foot, £72,562; a cubic yard, £1,959,552. The amount of gold in existence at the commencement of the Christian era is estimated to have been £85,400,000; at the period of the discovery of America it had diminished to £11,400,000; after the occurrence of that event it gradually increased, and in 1609 it attained to £21,000,000; in 1700, to £70,000,000; in 1800, to £225,000,000; in 1843, to £400,000,000; in 1853, to £600,000,000; and at the present time the amount of gold in existence is estimated to be £1,200,000,000, which, welded into one

mass, could be contained in a cube of 26 ft. Of the amount now in existence, £800,000,000 are estimated to be in coin and bullion, £200,000,000 in watches, and the remainder in jewellery, plate, &c.]

General Commerce. The following summary will give a collective view of the principal articles of commerce:—

VALUE OF THE IMPORTS IN 1870.

Amber, Rough and Manufactured...	£2,883
Bronze Manufactures, &c., from France	23,037
Cameos, unset	3,445
Coral Beads, &c.	13,324
Coral Negligées, Fragments, &c.	5,681
Gilt or Plated Wire	9,287
Gold and Silver Specie, and Bullion..	29,455,668
Gold Plate	230
Horns	179,969
Ivory	439,839
Jewellery	155,885
Medals	611
Mother-of-Pearl	76,489
Opera Glasses	49,412
Pearls	16,675
Platina	39,147
Plated Ware	1,838
Precious Stones	29,372
Silver Plate	20,448
Tortoiseshell	33,926
Vegetable Ivory Nuts	19,886
Watches and Clocks	631,048
Total	£31,208,000

VALUE OF THE EXPORTS IN 1870.

Amber	£789
Bells and Bell Metal	3,340
Bronze Manufactures	295
Buttons and Studs	4,519
Carried forward	£8,943

Brought forward	£8,943
Coral and other Beads	9,315
„ Negligées, &c.........................	1,035
Clocks and Watches, &c.	128,259
„ „ Movements......	27,381
German Silver Manufactures	7,498
Glass Beads (British).....................	12,784
„ „ (Foreign)	83,334
Gold and Silver Bullion..................	18,919,690
„ „ Lace	22,410
„ „ Plate	59,344
Hardware and Cutlery	3,670,519
Horns..	31,725
Horn and Bone Manufactures	16,184
India Rubber and Gutta Percha Manufactures	19,748
Ivory	3,252
Jewellery and Personal Ornaments...	274,015
Mother-of-Pearl Shells	20,787
Musical Boxes	1,372
Papier Mâché Manufactures	4,045
Pearls..	625
Pewter and Britannia Metal Manufactures	18,414
Plated Wares	131,413
Precious Stones	512
Scientific Instruments and Surgical Apparatus, &c.	108,681
Silver Plate	3,930
Spectacles....................................	277
Tortoiseshell................................	11,458
Toys	15,741
Travelling Bags, &c.	13,588
Turners' Wares.............................	11,450
Vegetable Ivory, &c., Nuts	10,382
Writing Desks and Dressing Cases, &c.	6,014
Total........	£23,654,125

THE GROCERY AND ALLIED TRADES.*

The various trades enumerated above are among the most numerous and influential in the kingdom, whether regard be had to the value and extent of the commodities dealt in, the continuous demand for them, or the number of persons employed in their preparation, commerce, and retail supply.

Passing the sub-divisions separately under review a collective estimate can afterwards be formed of their aggregate importance. They may be sub-divided into: First, the Grocery Trade; secondly, the Oil and Colour Trade; thirdly, the Confectionery Trade; fourthly, the Italian Warehouse Trade; fifthly, the Fruit Trade; and, sixthly, the Tobacco Trade.

1. The Grocery Trade. An estimate of the importance of the Grocery Trade for the supply of a native population amounting to 31,500,000, to say nothing of foreign visitors and ships' supplies at the outports, will best be formed from the figures of a year's foreign imports added to our home supplies. Some of the dairy produce passes through the hands of the grocer, although much is distributed by the

* Published as the Preface to Messrs. Kelly and Co.'s "Post Office Directory of the Grocery, Oil and Colour, Confectionery, Tobacco and Provision Trades, 1872."

cheesemonger, and hence butter, eggs, home-cured hams and bacon are added to other articles dealt in by the grocer.

It is not possible to ascertain precisely the entire number of persons who are engaged in the Grocery Trade, for, besides the wholesale and retail grocers, the publicans and some other classes have taken up the sale of tea. We know, however, from the Excise Returns, that there are 184,287 persons holding tea and coffee licences in the kingdom. Then, there are many cocoa and chocolate manufacturers—five of these employ 1,523 persons—the coffee-roasters, the condensed milk manufacturers, the starch and corn-flour makers, and many others who belong more or less to this trade.

In London and its suburbs there are about 4,800 wholesale and retail grocers; but this comprises only single firms or business houses, and includes but the one registered head of the firm, irrespective of the dozens of assistants, carters, and others engaged in the business.

The production and consumption of butter in the United Kingdom is very considerable, certainly exceeding 150,000 tons per annum, allowing only 16 lbs. yearly for each individual of two-thirds (21,000,000) of the whole population; and taking an average price of 1*s.* 3*d.* per lb. for fresh and salt all round, this gives a total value equivalent to £17,600,000. The consumption of cheese, based upon half-an-ounce per diem, or 12 lbs. a-year, for each individual of two-thirds of the population, amounts to 112,500 tons. The consumption of salt at 25 lbs. per head

gives an aggregate quantity, for the same proportions, of 234,375 tons; and there are 25 salt works, which employ 2,579 persons.

Wines are now very largely sold by grocers, but it is difficult to separate the grocers who hold licences from the wine merchants proper. We know, however, from the Excise Returns, that there are 434 grocers in Ireland who are retailers of spirits, and that there are 123 makers of and dealers in sweet, or made, wines in the United Kingdom, who hold licences, and 10,441 sweets' retailers.

Bottled beer, preserved meats, extracts of meat, fish—as sardines, herrings, &c., and marmalade, jams and fruits, now enter also into the trade of the grocer. Besides the large foreign imports there are 24 manufacturers of jams and fruits in the kingdom, employing 3,148 persons, and 26 miscellaneous manufactories connected with the preparation of food, employing 2,289 other persons.

2. The Oil and Colour Trade. The oil trade is another large and important branch of industry. In London and its Suburbs alone, which has one-tenth of the entire population, there are about 270 oil merchants, 1,440 oil and colour men, 30 oil brokers, 50 oil-refiners, 80 melters and tallow chandlers, 65 wax chandlers, 10 wax-vesta makers, and 100 soap-makers.

Fire-wood, matches, brushes, pails, and other domestic articles enter also into the range of articles sold by the grocer and oilman.

In London alone there are 33 candle makers, besides 5 candle works in the kingdom under the

Factories' Act, employing 1,438 hands, and 35 soap factories, employing 1,453 hands. There are also 308 soap makers in the kingdom, and 63 vinegar makers; one of the latter employs 104 persons.

The export trade in painters' colours has largely increased of late years, owing to the extensive emigration and progress of settlement in our colonies. In 1860 the value of the shipments from this country was but £475,143; in 1870 it was £644,331; against this we have to set foreign imports of painters' colours to the value of £120,209.

IMPORTS AND VALUE OF OILS AND FATS, &c., 1870.

Petroleum	tuns	2,013	...	£27,514
„ Refined	galls.	6,352,109	...	507,761
Train and Spermaceti	tuns	18,790	...	890,553
Palm Oil	cwts.	868,270	...	1,583,830
Cocoa Nut Oil	„	198,602	...	392,657
Olive Oil	tuns	23,202	...	1,185,950
Seed Oil	„	13,429	...	594,933
Turpentine, Oil of	cwts.	89,178	...	134,027
„ Common	„	83,460	...	28,063
Oil Seed Cake	tons	158,453	...	1,417,100
Lard Oil	cwts.	1,850	...	6,723
Tallow	„	1,523,298	...	3,292,215
„ Vegetable	„	1,638	...	3,261
Other Oils	„	20,105	...	36,062
Paraffine Oil	galls.	7,590	...	625
Paraffine	cwts.	11,835	...	36,804
			Total	£10,428,078

To the above must be added the following quantity of oil seeds imported chiefly to be crushed into oil at

our oil mills, and the oil is subsequently sold for home consumption:—

				Value.
Cotton Seed..................	tons	120,304	...	£1,091,132
Flax and Linseed	qrs.	1,502,169	...	3,960,717
Rape Seed	„	551,107	...	1,737,227
Hemp, Poppy and other Oil Seeds........................	„	112,627	...	310,097
		Total......		£7,099,173

There are 16 oil-pressers and oil-cake manufacturers registered under the Factories' Act, who employ steam power to the amount of 1,066 horses, and have 1,612 persons engaged.

3. The Confectionery Trade. In the United Kingdom confectionery is made in vast quantities. It is estimated that upwards of 650 tons of sugar are every week converted into confectionery, from the small comfits and bonbons up to the elaborate and expensive wedding cakes.

It is difficult to form any correct estimate of the fourteen factories, with 380 horse power steam, and 3,003 hands employed, which are returned by the inspectors of factories as bakehouses, and biscuit and confectionery manufacturers; and many others are not included because they do not employ steam power. There are also 44 sugar refineries in the kingdom, employing 5,174 persons. The exports of confectionery, to the value of £114,672, forms but a small proportion of the aggregate manufacture.

4. The Italian Warehouse Trade comprises a great variety of articles which it is scarcely possible to enumerate, but the following, which are particu-

larised in the Board of Trade Returns, may be specified, although some of them come within the proper business of the grocer:—

IMPORTS IN 1870.

	Value.
Capers	£8,646
Caviare	1,670
Honey	28,121
Lime and Lemon Juice	22,381
Liqueurs	39,046
Olives	2,306
Sauces or Condiments	8,939
Sausages or Puddings	6,749
Soy	9,621
Tongues	8,405
Truffles	30,211
Total	£166,095

Besides the above, anchovies and sardines, preserved salmon, lobsters, turtle, dried and preserved vegetables, condensed milk, and other articles form considerable articles of trade.

5. The Fruit Trade is divided a great deal between the grocer, the Italian warehouseman, the greengrocer, and the fruiterer proper.

The following was the value of some of the chief kinds of fruit imported in 1870 (exclusive of currants, figs and raisins, which pay a Customs' duty):—

Almonds, Sweet	£138,864
„ Bitter	20,966
Apples, Raw and Dried	274,058
Cherries	14,688
Carried forward	£448,576

Brought forward	£448,576
Chesnuts	22,108
Citron, Dried	11,281
Cocoa Nuts	30,622
Cranberries	4,780
Dates	70,611
Grapes	87,416
Nuts, Small	193,452
Oranges and Lemons	648,056
Pears and other Dried Fruit	1,119
Pears, Raw	20,340
Pineapples, Melons, and other Green Fruits	131,967
Preserved Fruit	8,918
Tamarinds	3,660
Walnuts	42,638
Total	£1,625,544

6. The Tobacco Trade. This is a business of large and growing importance, and there are a great number of persons employed in it as importers, brokers, manufacturers, and tobacconists, or retailers. Connected with the tobacco shop are also all those miscellaneous articles—pipes of different kinds, from the common clay to the expensively finished meerschaum, tobacco boxes and pouches, snuff boxes of various kinds, fusees, and other incidentals of the smoker. The number of licensed manufacturers of tobacco and cigars in the United Kingdom is 597, and these employ about 14,000 hands; of dealers or retailers holding licences there are 284,124. The quantity of tobacco and snuff of all kinds entered for home consumption in 1870 was 41,376,382 lbs., and the value of the imports was about £2,200,000.

7. General Commerce—Home and Foreign. The

following figures give the value of the exports and imports in 1870 of the principal articles :—

EXPORTS.

Almonds	£52,606
Bacon and Hams	413,079
Barley, Pearled	8,723
Biscuits and Bread	435,609
Blacking	22,586
Blue, Stone	20,417
Brooms and Brushes	56,287
Butter	410,118
Candles, Stearine, British	118,629
„ „ Foreign	277,136
„ other sorts	75,178
Cheese, British	110,246
„ Foreign	96,712
Chocolate	34,737
Cocoa	111,347
Coffee	393,268
Confectionery, British	70,787
„ Foreign	43,915
Currants, Figs, and Raisins	379,824
Emery and Emery Paper	15,223
Lard, British	8,561
Liquorice, Juice and Paste	70,165
Lucifer Matches and Vestas	169,356
Meat, Preserved	74,681
Oatmeal	5,549
Oils, Petroleum and other Oils	1,009,716
„ Olive	110,785
„ Seed Oil, British	1,286,275
Oil-cake	36,599
Oranges and Lemons	36,696
Pickles and Sauces	435,194
Rice	1,175,554
Carried forward	£7,565,558

Brought forward	£7,565,558
Salt	381,888
Soap	8,345
Soda	1,486,045
Spices	473,273
Starch	70,016
Sugar, Refined	986,394
„ Unrefined	426,190
„ Molasses	21,813
Tallow	97,503
Tea	2,187,721
Tobacco	639,519
Vinegar	34,486
Wax, Bees'	83,394
Whiting	13,787
Wine, British	3,463
Yeast	31,504
Total	£14,510,899

IMPORTS.

Arrowroot	£33,063
Bacon and Hams	1,792,569
Biscuits	4,698
Brooms and Brushes	26,035
Butter and Cheese	10,068,208
Candles, Stearine	285,333
„ other kinds	91,119
Chicory	43,756
Cocoa and Chocolate	386,909
Coffee	4,942,769
Colours for Painters	120,209
Eggs	1,102,080
„ from Ireland	300,000
Fruit, Dried, Currants, &c.	1,755,299
„ other kinds	1,626,544
Isinglass	83,022
Carried forward	£22,641,613

Brought forward	£22,641,613
Italian Warehouse Goods	127,049
Lard	727,192
Liquorice	68,603
Lucifers and Vestas	44,541
Macaroni and Vermicelli	25,452
Meat, Preserved	231,860
Oils and Fats and Oil-cake	9,273,208
Oil Seeds	7,099,173
Onions	390,830
Orange and Lemon Peel	17,179
Pickles	52,984
Pumice Stone	2,720
Resin	373,918
Rice	2,310,352
Saffron	95,690
Sago	218,400
Salt	23,820
Semolina	4,217
Shrub and Cordials	39,046
Soap	8,832
Spices	854,300
Starch	26,966
Sugar, Raw	14,440,502
„ Refined and Candy	2,744,366
„ Molasses and Syrup	412,789
Succades and Confectionery	128,594
Tapioca	89,635
Tea	10,097,619
Tobacco	2,169,053
Vanilla	9,706
Vinegar	4,699
Yeast, Dried	286,097
Total	£75,341,005

Irrespective of the sale of wine and of malt liquors in bottle, and of the trade in starch, soap, candles

mustard, salt, pickles and sauces, marmalade, jams and jellies, butter, cheese and eggs, bacon and hams of home production, we have in the above figures an aggregate import trade of the value of upwards of £75,000,000, and we certainly cannot assume the value of the articles of home production at less than £35,000,000, so that, with a number of miscellaneous, small, unenumerated commodities, the aggregate trade may be fairly estimated to amount to £110,000,000.*

THE TRADE IN GROCERIES.†

GROCERIES in early times consisted chiefly of spices, particularly pepper, then a scarce and dear article; but subsequently came to comprise confectionery, dyes, drugs, chemicals, and whale oil, &c., as may be seen in the early history of the Grocers' Company, which was originally instituted as the Pepperers' Guild. They are mentioned by Lydgate to have had standings as retail spice dealers in Chepe.

The word "grocer" was a term at first employed to distinguish merchants of this Company from humbler traders. In some old books the word signifies a merchant who dealt wholesale or in the gross; but in after

* The English prices of tea, chocolate and coffee 162 years ago are shown by the following advertisement taken from the "Daily Courant" of January 11, 1710. "The finest coffee in England 6*s*. a lb. Excellent Bohea tea at 16*s*. and 20*s*., and the finest at 24*s*. a lb. Green tea at 12*s*., and the finest at 16*s*. a lb. Chocolate, all nut, 3*s*., nut and sugar, 2*s*. a lb. Sold by Lawrence Green at the Two Great Posts in Dean Street, near Fetter Lane. N.B.—Good encouragement will be given to a quantity."

† Published in "The Grocer," January 4, 1862.

times this expression became specially employed in relation to kinds rather than to quantities of goods. An old historian of the Grocers' Company, quoted by Herbert in his "Livery Companies of London," claims for them, however, a high rank among the merchants of the metropolis; indeed, the Grocers' Company stands second on the roll of City Companies. "They have been the most universal merchants that traded abroad; and what they brought home, many artists among them found out ways afterwards to change and alter the species, by mixture, confection, and composition of single ingredients; by which means many and various ways of dealing and trading passed under the name of groceries; and, indeed, this city and nation do, in a great measure, owe the improvement of navigation to merchants originally exercising their mystery as traders into all foreign parts from whence we have received either spices, drugs, fruits, gums, or other rich aromatic commodities."

The Grocers' Company was incorporated 1345, under the patronage of St. Anthony, by a charter granted by Edward III., under the title of "The Wardens and Commonalty of the Mystery (a corruption of the old French term, *méstière—métier*—for trade or craft) of Grocers of the City of London." The grocers—dealers *en gros*—were originally styled pepperers (when first mentioned, as *Gilda de Piperiorum*, among the amerced guilds of Henry II.), from the chief article of their trade, and the latter remained a distinct body so late as 1559, when they purchased from the Queen a cargo of pepper captured in a Spanish vessel, and on the grocers underselling them, petitioned Her Majesty

to forbid the importation of pepper, to enable them to keep their pecuniary engagements with her—promising not to raise the price above 3*s*. the pound.

The vast extension of commerce, and the progress of population, have led in modern times to many subdivisions of trade, so that we have now East and West India merchants, produce-brokers, drysalters, oilmen, Italian warehousemen, fruit merchants, and others interested in articles which were formerly included under the collective term of groceries.*

* According to the "Post Office London Directory" for 1871 there were in London 1,960 wholesale and retail grocers, 21 coffee and cocoa roasters, 5 coffee brokers, 6 coffee roaster makers, 7 tea and coffee urn makers, 3 spice brokers, 27 spice merchants, 18 sugar brokers, of whom 7 are refined sugar dealers; 30 sugar refiners, 7 sugar refiners' iron mould makers, 25 chocolate and cocoa manufacturers, 1 maker of essence of coffee. One of the peculiarities in the retail trade of modern London is the immense extent of, and amount of business done by, a new class of shops which have sprung up, and may be called wholesale-retail grocers, and another, the establishment of co-operative stores, to bring down the profits of retailers, and thus benefit the consumers. Until quite recently most persons dealt with the nearest grocer, and an established tradesman consequently had a practical monopoly of the houses within a certain distance of his shop, but, as London has spread and overflowed into the country, some of the leading shops have seen the advantage of establishing communications with districts at a distance from their places of business. By means of a skilfully-organised carrying system, they permeate the whole of London and the suburbs, doing an amount of business which would have astonished their predecessors. This class of shopkeepers has also derived great advantage from the railway system, which both brings them customers and enables them to supply goods to remote distances without the cost of carriage sensibly increasing the price of the articles.

The commodities in which the grocer deals are chiefly exotic products, and hence, in order to have a thorough knowledge of the markets, the probable future supplies and range of prices, he requires to be kept well informed as to the crops and seasons, the demands for shipping as influencing freights, the labour market in the producing countries as affecting supplies, the alteration of foreign duties, the stocks held, and various other matters. A short or abundant crop of sugar, coffee, fruit, &c., in any producing country, may materially affect the course of his trade, and interfere with his profits. Hence the necessity of his being well advised on all matters affecting his interests. Brokers and merchants keep themselves posted up on these subjects by the aid of their foreign correspondents, business circulars, and colonial files; but the retail dealer has seldom such advantages; for the existing commercial journals take so wide a range that they can devote but a very small space to the tropical produce generally interesting to the grocer.

In order to show how important is the trade to which we address ourselves, and what a large amount of capital is embarked therein, we shall endeavour to furnish an approximate abstract of the imports and their value.

Although the duty has been abolished on a large number of articles, yet the Customs' revenue derived from grocery products in 1860 amounted to £12,500,000 sterling; of this two commodities yielded the principal sum, namely, sugar and tea, the former contributing £6,000,000, and the latter nearly £5,500,000.

Ten years ago (1852) Mr. Braithwaite Poole, in his "Statistics of British Commerce" (computed for rail-

way purposes), gave the following as the estimated annual average weight and value of the articles, produced or imported, in which the grocer is more or less interested, stated in round numbers :—

	Tons.	Value.
Anchovies	65	£7,800
Arrowroot	450	27,000
Candles	58,000	3,080,000
Capers	40	8,000
Carraway Seeds	500	16,500
Chicory Root	70,000	280,000
„ Powder	14,000	308,000
Cinnamon	15	4,000
Cloves	150	14,000
Cocoa and Chocolate	1,800	87,000
Coffee	15,000	750,000
Cranberries	160	3,000
Currants	20,000	850,000
Figs	1,600	72,000
Grapes	540	30,000
Honey	2,000	80,000
Isinglass	90	10,000
Liquorice	400	24,000
Macaroni	50	2,500
Mace	8	2,000
Molasses	40,000	560,000
Mustard	2,000	160,000
Nutmegs	75	27,000
Pepper	2,800	110,000
Prunes	1,300	35,000
Raisins	12,000	550,000
Rice	50,000	850,000
Sago	2,600	45,000
Starch	20,000	460,000
Sugar	435,000	15,675,000
Sweets and Cordials	200	2,000
Tapioca	70	2,000
Tea	21,500	9,675,000
Total	772,413	£33,806,800

It is true that all the quantities of these several commodities do not pass exclusively through the hands of the grocer. But then there are many unenumerated articles in which he also deals, and, moreover, the progress of trade has been so great in the last ten years, owing to the extension of shipping and steam, and the progress of free trade, with the reduction of duties and the improved condition of the people, that the foregoing estimate is far from being accurate at the present time. In proof of this we append the official returns of foreign imports of the principal groceries, &c. Many of the articles are, no doubt, participated in by the Italian warehousemen and oilmen, but the bulk of them belong specially to the grocery trade.

Imports in 1860. Quantities and value taken from the Board of Trade Returns :—

	Quantity.	Value.
Almonds, Sweet ....cwts.	19,638	£71,138
" Bitter .... "	7,361	16,141
Anchovies ....lbs.	340,044	8,504
Apples, dried ....bushels.	7,638	7,638
Arrowroot ....cwts.	21,282	42,484
Capers ....lbs.	111,225	5,5[illegible]
Carraway Seeds.............. "	8,869	16,016
Cassia Buds.................... "	30,838	2,545
Cherries, dried.............. "	2,297	51
Chicory, raw ....cwts.	94,287	31,966
" roasted ....lbs.	38,631	401
Chocolate .... "	33,747	1,761
Citron Peel.........................	———	7,092
Cocoa ....lbs.	9,009,860	274,541
" Husks and Shells...cwts.	13,244	11,035
Coffee.............................lbs.	82,767,746	2,543,307
Cranberries ....galls.	62,749	2,954

Currants ....cwts.	755,415	......	852,863
Dates .... „	11,301	......	17,186
Dried Plums .... „	4,734	......	13,615
Figs .... „	92,109	......	136,302
French Plums ....cwts.	6,174	......	28,287
Grapes ....bushels.	12,717	......	7,760
Isinglass .... „	2,595	......	85,323
Liquorice Paste and Juice. „	31,917	......	99,454
Macaroni and Vermicelli. . „	6,445	......	14,206
Olives ....galls.	10,634	......	592
Prunes ....cwts.	22,482	......	23,249
Raisins .... „	284,557	......	400,807
Rice .... „	1,524,863	......	1,023,108
Sago.............................. „	179,825	......	149,748

These figures give a total sum of nearly £6,000,000 paid for imported grocery articles, exclusive of butter, bacon, cheese, and other provisions.

THE LEATHER TRADE AND TANNING SUBSTANCES.*

Although much has been done to utilise the barks of trees, and to turn them to account for the service of man in various ways, it is only of late years that chemical science and close analytical investigation are bringing out the comparative properties and more important uses of the inner and outer barks of trees. A long and extensive acquaintance with their properties is, however, necessary in most instances to test the asserted value and alleged benefits of many.

The importance of the Leather Trade may be estimated from the following figures. Exclusive of the hides and skins tanned, tawed, curried, &c., we imported in 1854 the following undressed skins:—

Goat Skins	585,143
Seal Skins	661,552
Lamb Skins	1,924,918
Sheep Skins	779,373
Hides	601,199
Total number	4,552,185

Besides these there were imported 4,500,000 lbs. of leather, 578,136 pairs of boot-fronts, and 231,000 pairs of men's and women's shoes. But to reduce the above

* Published in the "Farmers' Magazine," 1855.

to leather (although some probably are destined for other purposes), we will take the

	Tons.
Total imports of Skins at	30,000
The common estimate is that one-fourth of our live stock is slaughtered annually; this will furnish us with, for the United Kingdom, 4,000,000 Ox and Cow Hides, at 28 lbs. ...	50,000
500,000 Calf Skins, at 4 lbs.	900
8,000,000 Sheep and Lambs' Skins, at 1 lb. ...	3,570
100,000 Horse Hides, at 14 lbs.	625
100,000 Goat Skins, at 1 lb.	45
Total leather produced	85,140

A portion, however, of these hides and skins is exported, to the extent of about 5,000 tons. Now there are about 500 tanneries in the United Kingdom, employing 350,000 persons directly or indirectly. The greater portion of this manufacture is used at home, the declared value of the exports of this branch of trade being only about £1,300,000. The home consumption of leather necessarily keeps pace with the increasing prosperity of the industrial classes; recently, the demands, for various purposes of the war, have led to an enormous consumption.

TANNING SUBSTANCES.

Coming, now, to the substances containing the principle essential to the conversion of skin into leather, we find these to be very numerous, and scattered over every quarter of the globe. Proximity of supply and cheapness necessarily guide the tanner in his choice of material in different localities. If we take a recent year's imports of tanning substances at the current prices of the day, and add thereto the indigenous barks by estimate, we shall arrive at some

approximate idea of this important branch of trade. The imports then, were, in 1854—

Foreign Barks of all kinds, 420,621 cwts., at an average of £7 per ton	£147,224
Sumach, 230,480 cwts., at 16*s.* per cwt. ...	178,984
Valonia, 397,720 cwts., at £16 per ton ...	318,176
Terra Japonica, 90,940 cwts., at £20 per ton ...	90,940
Cutch, 38,300 cwts., at £30 per ton	57,450
Divi-divi, Myrobalans, &c., 4,000 tons, at £12 per ton	48,000
Oak Bark, 200,000 tons, at £6 per ton ...	1,200,000
Larch Bark in Scotland, 50,000 tons, at £4 per ton	200,000
The value of the Leather made, about ...	16,000,000
Total ...	£18,240,774

The imports of bark proper for tanners' and dyers' use are mixed up in the Parliamentary returns, so that it is impossible to ascertain precisely the proportions of each; but the quarters whence they are received affords some index. In 1854 the aggregate quantity of these barks imported amounted to 21,032 tons. The average annual quantity of barks and other substances imported for the use of tanners and dyers in the six years ending with 1854 was 407,935 cwts. of sumach; 232,206 cwts. of valonia; 302,570 cwts. of terra japonica; 91,153 cwts. of gambier; and 34,723 cwts. of cutch. The imports of valonia now nearly equal the amount of bark imported, and from the great quantity of tannin it furnishes, valonia fetches twice the price of oak bark. The value of these acorn cups received in 1854 was upwards of £270,000. In aggregate value, sumach ranks next, and the various barks third in rotation.

In 1816 the imports of oak bark were under 5,000

tons, but in 1823 they had risen to 46,674 tons: a large quantity of cork-tree bark was then included in the returns. The consumption of indigenous oak bark in Great Britain is now fully 150,000 to 200,000 tons —many large brokers estimate the quantity at 300,000 tons; and we import, on the average of years, 53,500 tons of various tanning substances. Last year (1854) it amounted to 59,000 tons, the value of which was fully £750,000, whilst that of our own oak and other barks used could scarcely be less than £1,500,000 sterling. Besides barks, various other substances — fruits, seeds, extracts, &c. — are imported for the use of the tanner, of which the chief are, valonia, camata and camatina, the acorn cups, mature and immature, of a species of oak, *Quercus ægilops*, growing in the Levant; divi-divi, the wrinkled pods of *Cæsalpinia coriaria*, from South America and Central America; and myrobalans, the dried fruits of some species of *Terminalia*, from the East Indies, &c. By chemical process the tanning principle is now extracted from barks and woods, and, thus reduced to a small compass, the concentrated extracts are more easily imported from distant quarters, saving the freight on bulky articles. In this form we receive gambier or terra japonica, cutch or catechu, and a variety of kinos. Oak bark being the usual substance employed by the trade for tanning, the value and commercial utility of other barks and tanning principles are necessarily determined by comparison with it. Oak bark is the mainstay of the tanneries of the United Kingdom, both in London and the Provinces, although larch bark is now used to a considerable extent in Scotland.

Oak Bark contains of Tannin		....	14·0	per cent.
Coppice Bark	„	„	4·5	„
Mimosa Bark	„	„	3·7	„
Sumach	„	„	1·9	„
Divi-divi	„	„	4·9	„
Myrobalans	„	„	3·8	„
Valonia	„	„	2·9	„

From 2,000 to 5,000 tons per annum of foreign oak bark have come in to aid our supplies.

The consumption of tannin in our leather manufactures may be estimated from the fact that nearly 600,000 cwts. of raw hides are imported annually, besides the hides of the cattle slaughtered in the United Kingdom. The imports of bark and various tanning agents are very considerable.

There are a vast number of barks and other substances useful for tanning purposes, abundant in the tropical regions, and in many of our colonial possessions, which are comparatively unknown and little regarded in Europe, but which might readily be obtained in large quantities and at a trifling cost.*

* The following is a list of tanning barks, &c., information on some of which would be valuable. Tanning barks—*Inga dulcis*, Guadaloupe; *Rhizophora Mangle*, Guadaloupe; *R. mucronata*, New Caledonia; *Malpighia spicata*, Guadaloupe; *Casuarina latifolia*, Pondicherry; *C. muricata*, Pondicherry; *Baloghia drupacea*, New Caledonia: *Bruguiera gymnorrhiza*, New Caledonia; *Mangifera indica*, Mayotte; *Conocarpus species*, Martinique; *Imbricaria borbonica*, Reunion; *Bursonina spicata*, Pondicherry; *Catalpa longissima*, Martinique; *Casuarina equisitifolia*, Martinique; Bancoulier (*Aleurites triloba*), Reunion; hemlock spruce (*Abies canadensis*), North America; common alder; pods of *Acacia Adansonia*, Senegal; of *Acacia nilotica; Quercus suber*, Barbary, Sardinia, and Tuscany. 4,500 to 5,500 tons of tanning barks are exported annually from South Australia.

Catechu and gambier are very valuable to the tanner, and are now in extensive demand. The bark of many species of Mimosa furnishes the tanning principle in a great degree, particularly that of *Acacia arabica*, which, under the name of Babool wood, is largely used about Scinde, Bellary, Guzerat, and other parts of India. The fruit of this species, and of *A. vera*, termed Egyptian and Senegal bablah, have long been used both for tanning and dyeing. Many species of this tribe are abundant in New South Wales and the Cape Colony, where, from their astringent properties, they are in common use. *Mesembryanthemum nodiflorum*, one of the numerous indigenous species of Africa, is used in making morocco leather. The bark of the hemlock spruce (*Abies canadensis*) is extensively employed for tanning in New Brunswick and the United States. The bark of *Cassia auriculata*, and the milky juice of *Calotropis gigantea*, are used in India to dye leather. The sea-side grape vine (*Coccoloba uvifera*) yields an astringent substance known as Jamaica kino.

In Peru the bark of some species of *Weinmannia* is used. From Chili about 2,000 cwts. of quillai and other barks suited for tanning are annually shipped. Among other powerful astringents, I may notice the root of a species of sea lavender, *Statice caroliniana*, and *S. coriaria*, in Russia, *Myrica cerifera*, and *Heuchera americana*, natives of North America; also the petals of *Hibiscus rosa-sinensis*, a native of Asia.

A large quantity of tannin is extracted from various species of *Eucalypti*, the gigantic gum tree of Australia and Tasmania, of which quarter all these trees are

natives. It is said to be twice as powerful as the best oak bark. A sort of astringent kino gum is also extracted from *E. resinifera*, *E. leucoxylon*, and *E. viminalis*. It exudes in the form of a red juice from incisions in the bark, and a single tree will often yield 60 gallons.

In the instructions given to Captain Sir James C. Ross, by the Admiralty, previous to his departure on his Antarctic voyage, he was particularly enjoined to make special enquiries as to the astringent substances adapted for tanning, and as to the various extracts of barks, &c., imported into England from the Australian settlements, and which are employed by the tanner. Much satisfactory information has since been obtained as to the qualities of the astringent gums, barks, and dyes yielded in such abundance by the trees of those colonies, and the proportion of tannin they contain; this has chiefly been accomplished through the scientific investigations of Baron Mueller, F.R.S., the Government botanist at Melbourne.

The extracts procured from the bark of the *Buchanania latifolia*, the *Syzigium jambolanum*, &c., are likely to be of consequence to the tanner, and could be procured in India in large quantities. Specimens of these, and of the bark of the Sal tree (*Shorea robusta*), of *Nyctanthes arbortristis*, *Terminalia angustifolia*, and of the gaub fruit (*Diospyros embryopteris*), were shown at the Exhibition in 1851 by the Honorable East India Company. The bark and rind of the fruit of the pomegranate (*Punica granata*) have strong astringent properties. The red astringent gum obtained from *Butea frondosa*, common in Bengal and the mountain-

ous parts of India, is used by the natives for tanning. English tanners, however, object to its use on account of the colour which it communicates to the leather.

The barks of *Mora excelsa*, Bentham; Courida (*Avicennia nutida*), and Cashaw (*Spondias lutea*, Linnæus), have all been successfully used for tanning in Demerara and the West India Islands, where they are abundant. Among the barks used for tanning in British Guiana are brown and yellow silverballi from species of *Nectandra* or *Oreodaphne*, moss-apple bark (*Blakea quinquenervia*, Aublet), *Simaruba officinalis*, Decandolle, and undefined barks, known as bloodwood and comacoballi bark. The root of the Palmetto palm (*Chamærops palmetto*) is stated to be valuable for tanning purposes. The leaves of *Nerium oleander* contain tannic acid, and the bark of a species of *Malpighia* is much used by the Brazilians; so is the bark of *Avicennia tomentosa*. *Coriaria myrtifolia* is not only used in tanning, but also for staining black. The bitter astringent bark and the galls of the Tamarisk tribe are well suited for tanning. In Scinde and other parts of Asia the bark of *Bauhinia variegata* is made use of. *Pterocarpus marsupium* furnishes, about Tellicherry, one of the red gum-resins, known in commerce as kino; being a powerful astringent, it may be used for tanning.

The plants of the mangrove tribe, *Rhizophora Mangle*, and other allied species, have frequently an astringent bark, which is in many cases used for tanning and dyeing black. This tree is very common in most tropical regions, where it forms dense thickets on the muddy banks of rivers and the sea shores.

The panke (*Gunnera bracteata*) is a fine plant, growing in Chili on the sandstone cliffs, which somewhat resembles the rhubarb on a gigantic scale. The inhabitants eat the stalks, which are sub-acid; tan leather with the roots, and prepare a black dye from them. The leaf is nearly circular, seven or eight feet long, and as much as twenty in circumference, its margin being deeply indented.

The bark of the various trees replete with the tanning principle should be stripped with hatchets or bill hooks, from the trunk and branches of the trees, in spring, when the sap flows most freely. The following figures show the quantity of extractive matter and tannin yielded by different substances.

	In 480 parts by Davy.	In 100 parts by Cadet.
Sicilian Sumach	78	
Malaga ditto	79	
Bombay Catechu	261	
Bengal ditto	231	
Nutgalls	127	46
Bark of Pomegranate		32
„ Virginian Sumach		10
„ Carolina ditto		5

Oak bark contains usually the largest proportion of tannin, and according to Davy's experiments 8½ lbs. of oak bark are equivalent for tanning purposes to 2¼ of galls, 3 of sumach, 7½ of Leicester willow, 11 of Spanish chesnut, 18 of elm, and 21 of common willow bark. Tannin obtained from these sources, however, differs materially in some of its characters. The tannin of nut-galls, which is that generally employed for chemical purposes, is sometimes called gallo-tannic acid, to distinguish it from the other species.

The imports of bark for the use of tanners and dyers amounts yearly, at this date (1854), to the very large quantity of 380,674 cwts., besides what we obtain at home.

Divi-divi is the commercial name of the curved pods of a leguminous shrub, *Cæsalpinia coriaria.* The quantity of mucilage it contains precludes it from being used by dyers, but from the large quantity of tannin, (nearly 50 per cent.), it is much used by curriers. It has been imported from the West Indies, from Rio de la Hache, Maracaibo, Savanila, and Angostura. The tree yields about 100 lbs. weight of pods, of which one-fourth is refuse, seeds, &c., and the remainder marketable produce. The culture of this shrub for its tannin might become a valuable object of attention to the planter, as it requires no care, and will grow well on soils not adapted to the staple products. The East India Company exhibited specimens of divi-divi which had been grown at Calcutta. 400 tons of the seed pods of the Algaroba, or locust tree, have been imported in a year into Liverpool from Valparaiso, as a substitute for divi-divi in tanning.

Catechu (from *Cate* tree, and *chu* juice), is obtained from the *Acacia catechu,* and when of good quality is more powerful as an astringent than kino. The tree is a native of the East, but is also common in Jamaica. The catechu obtained in Pegu is celebrated throughout India, and sells at a higher price than gambier and other astringent extracts. The inner dark wood of the tree is chipped and boiled down to a sufficient consistence, when it is poured into clay moulds. Catechu is included under the term "cutch" in the

official trade returns. Of all the astringent substances we know, this appears to contain the largest proportion of tannin, and Mr. Purkis found that 1 lb. was equivalent to 7 or 8 lbs. of oak bark for tanning leather. Catechu is used in Berar in the process of dyeing chintz and other cloths.

Cork-tree bark (*Quercus suber*) is imported to the extent of 3,000 tons annually, but, from being less astringent than oak bark, it is not much used for tanning when valonia and oak bark are cheap.

Valonia is the commercial name for the cupules or cups of the large acorn produced by the *Quercus ægilops* and its varieties—natives of the Levant, from whence, and the Morea, they form a very considerable article of export. Affording an abundance of tannin, they are largely used in preparing hides. The bark of *Q. tinctoria*, a native of North America, furnishes a yellow dye. The annual produce of valonia from the shores of the Mediterranean coasts is sufficient to meet the wants of all Europe. In Turkey it can be had to any extent, and at all periods. The price in the London market is about £17 per ton, and the average annual imports of late have been about 25,000 tons; which is a very considerable increase on preceding years.

The bark of the *Acacia decurrens*, which abounds in Australia and Tasmania, is found to be a very powerful tanning agent. The first shipment of tannin was made from Sydney to England as far back as 1823, in the shape of an extract of the bark of two species of Mimosa. 1 ton of bark afforded 4 cwts. of extract of the consistency of tar. This extract was readily

purchased by the tanners at the rate of £50 per ton. In 1843, upwards of 3,000 tons of this mimosa bark was shipped from Port Phillip to Britain. The price then realised in the London market was £12 to £14 per ton, but it has since declined to £8 or £9 per ton, and the export has dwindled to about 350 tons. The quantity of this bark to be procured in Australia is quite inexhaustible, and ought not to be overlooked. From an experiment conducted by Professor Brandt, the strength of mimosa bark, as compared to the best English oak bark, is found to be in the proportion of 57 to 39; so that mimosa bark is half as strong again as the best English bark. Mr. Samuel Mossman, in a communication to the Botanic Society of Edinburgh in 1852, states that the bark of *Acacia dealbata* pays to ship to England, notwithstanding the distance, from the fact of its containing a greater percentage of tannin than any other bark. It is a handsome tree, from fifteen to twenty feet high, forming luxuriant groves on the banks of streams, most abundant in Port Phillip and Twofold Bay, between the parallels of latitude thirty-four degrees and thirty degrees.

New Zealand is rich in barks and native dyes, which may be easily obtained in large quantities. The bark of the Rimu, or red pine, *Dacrydium cupressinum*, Banks, a very common tree, possesses, it is said, tanning qualities far superior to any of the Australian barks; 1 lb. of the bark yields 85 grs. of extract. The Towai (*Weinmannia racemosa*, Forster), would also be valuable for the purposes of the tanner, as it is said to yield 104 grs. of tannin for every lb. of bark. The bark of the Sohutu kawa, of the natives (the

Metrosideros tomentosa, of Richard); affords 60 grs. of tannin to the lb. The bark of the hinau tree, *Elæocarpus hinau*, Cunningham—the *Dicera dentata* of Forster—is used by the natives for dyeing black. The bark of the Tanekaha (*Phyllocladus trichomanoides*, Don), is used by the natives as a red dye for the ornamental parts of their kaitakas, their best border garments. There is also another red dye called tawenwai, the bark of which is very plentiful. These are of rich hues and exceedingly fast colours. The trees are to be found all over the Colony. Specimens of the bark and dye of most of those named were exhibited in 1851 at Hyde Park. 1 lb. of the Tanekaha bark is said to yield 63 grs. of tannin. The sails of boats are dyed with it to preserve them. The Hinau and Tanekaha barks are employed in tanning the leather used in the Colony.*

* Up to the present time the only New Zealand plants in which the amount of tannin has been ascertained in sufficient quantity to render their adoption a substitute for foreign substances in the process of tanning at all probable, are the bark of the Pokako (*Elæocarpus hinau*), certain parts of the Tutu plant (*Coriaria ruscifolia*), and the bark of the white birch (*Fagus solandri*).

The Pokako is, however, a solitary-growing tree, a circumstance likely to prevent its use to any important extent. The Tutu plant, on the other hand, frequently occurs in natural shrubberies, sometimes extending over considerable areas. As this plant appears a very likely substitute, several experiments were made upon it, the results of which were as follows: The tannin (or tannic acid of some) was found to be abundantly diffused in the leaves, in the old wood, in the roots, in the pith of the old wood, in the flower stalk, the calyx, and in the crushed seed; in the outer pith of strong shoots traces of it are also found.

Mangrove. Almost every part of the black mangrove (*Rhizophora Mangle*), the bark, roots and the

The amount of tannin found in different parts of the plant is given in the table below; it is calculated both upon the green and dried plant:—

	Lost by drying.	Percentage of Tannin in natural state.	Percentage in dried state.
1. New shoots with leaves...	75	2·08	8·32
2. Roots..........................	57	1·66	3·86
3. Last year's shoots without leaves	69	1·60	5·16
4. Old shoots and leaves......	70	1·26	4·20
5. Old wood without leaves..	59	1·25	3.05
6. New shoots do. do.	68	·30	2·14

From the acknowledged difficulty attending the estimating tannin in its weak solution, these figures are only offered as a near approximation to the actual amount, but they will express pretty accurately the proportionate richness of the several parts of the plant to each other on this principle. It will be observed, by a comparison of Nos. 1 and 6, how much richer the leaves are in tannic acid than the succulent watery shoots; and again, on referring to Nos. 2 and 6, it will be seen that the last year's shoots are not so rich as the roots. From a number of experiments it was found that there was no perceptible loss of tannin occasioned by drying the plant at a temperature from 130° to 150°; the small branches could therefore be dried and stacked in the same manner as hay, without losing any of their useful properties.

A sample of the white birch bark from Southland was found to contain about 2·60 per cent. of tannin, which is a little more than is furnished by the Tutu plant in its natural humid state, but is considerably less if the dried plant be taken. Two kinds of bark exhibited by Mr. G. L. Cole, of Papatura, Province of Auckland, as dyers' barks, were the richest in tannin of all the exhibits of the kind, the white bark containing 8·60 and the red bark 6·0 per cent. of this principle. These

fruit more particularly, abounds in tannin. As the tree is so abundant within the Tropics, it would pay some practical speculator well to make an extract on the spot, and introduce it into the English market, for the use of the tanner and dyer. The bark and leaves are used for the purpose in the West Indies, Scinde and other parts of Asia, and there seems a demand for it, since it appears that 3,713 piculs of its bark, valued at £819, were shipped from Shanghae in China, in 1849. It is reported to be infinitely superior to oak bark for tanning, completing in six weeks an operation which with the latter occupies at least six months, and the sole leather so tanned is said to be more durable than any other.

were red bark of *Phyllocladus trichomanoides* (native names, Tanekaha, and Toa Toa); and the white bark of *Elæocarpus Hookerianus* (native names, Hinau, Pokako, and Mahimahi).

Many other New Zealand plants are known to contain a marked amount of tannin, of which the principal are the Manuka (*Leptospermum*), Rata (*Metrosideros*), Fuchsia tree (*Fuchsia excorticata*), Matapau (*Myrsine*), and Red Birch (*Fagus Menziesii*). Jury reports, "New Zealand International Exhibition, 1865."

The following percentages of tannin in the barks of certain trees will afford useful comparison; they are taken from "Muspratt's Chemistry Applied to the Arts and Manufactures."

Young Oak Bark, spring cut	22·0
" "	15·0
" entire Bark	6·0
Willow, entire Bark	6·8
Elm "	2·9
Beech "	2·0
Larch "	1·6

Extensive as has been our enumeration of the animal and vegetable substances used for the objects of the branches of art and manufacture which have formed the principal subjects of this article, it is probable that with the progress of knowledge, of scientific experiment, and of investigation into the properties of given commodities, the list might be indefinitely increased. What we have stated will suffice to give the general reader an idea of the surprising variety of sources from which we receive the materials which enable us to perfect some of the most elegant processes of manufacturing skill and ingenuity, and will further afford some criterion—though, of course, not a perfect one—for estimating the relative importance of the materials in question.

THE LEATHER MANUFACTURE.*

Next to wool, the Leather Trade forms one of the largest industries connected with animal products in the United Kingdom; an idea of its importance, in a manufacturing point of view, can only be arrived at, however, after a careful examination of some of the statistics connected with the products employed.

In 1850, only about 6,000,000 of hides and skins, adapted for various descriptions of leather, were imported; now the quantity received from abroad exceeds 14,000,000 annually, to say nothing of peltries and furs.

* Published as a Preface to the "Post Office Directory of the Leather Trades." Kelly and Co., 1871.

Foreign Imports of Hides, Leather, Skins, &c., 1870 :—

	Quantity.		Value.
Deer Skins......... number	40,987	...	£4,704
Goat do. Tanned, Tawed, and Undressed............	3,487,859	...	404,947
Kid do. do. do. ...	449,113	...	35,874
Lamb do. do. do. ...	987,858	...	50,479
Seal do.	731,913	...	270,024
Sheep do. do. do. ...	7,980,694	...	585,801
Unenumerated Skins......	353,887	...	59,759
Hides, and Pieces of Hide, Unenumerated............	——	...	7,843
Hides, Dry and Wet, cwts.	1,199,050	...	3,842,315
Tanned Leather.............	8,882,063	...	409,760
Tawed or Curried...........	1,808,807	...	137,128
Varnished Leather.........	733,822	...	195,448
Russia do.	131,653	...	17,006
	Total...........		£6,021,088

The common estimate is that one-fourth of our live stock is slaughtered annually, and, according to the last agricultural statistics for the United Kingdom (1871), this would give the following number of hides, besides some few skins from imported live stock slaughtered. Taking them at the leather value there would be :—

Ox and Cow Hides and Calf Skins, 2,350,000, at an average of 28 lbs., at 1*s.* 6*d.* per lb.	£4,935,000
Sheep and Lamb Skins, 8,000,000, at 1 lb., value 1*s.* each	400,000
Horse Hides, 500,000, at 15*s.* each .	425,000
Total	£5,760,000

Besides some goat and hog skins.

We imported, in 1870, 1,199,000 cwts. of hides; of tanned leather, 11,424,692 lbs.; of other leather manufactures—boots, shoes, and goloshes of all kinds, 534,648 pairs; of boot fronts, 86,952 pairs; and of gloves, 10,896,432 pairs. A portion, however, of these hides and skins are re-exported to the extent of nearly 17,500 tons.

There are now about 770 tanneries in England, Scotland and Wales. These and the leather trades connected therewith give employment to about 400,000 persons, directly or indirectly.

If the foregoing estimate be any way near the mark, the 80,000 tons of leather used at home would be worth in the rough at, say 1*s*. 6*d*. per lb., £13,240,000, but by the processes of manufacture the value is very largely increased.

Estimated value of the tanning substances imported in 1870:—

	Quantity.				Value.
Mimosa, Oak, Cork, and other foreign Barks.	24,660	tons at	£6	...	£148,260
Sumach	14,431	„	20	...	288,620
Valonia	25,781	„	12	...	309,372
Gambier and Cutch ...	25,000	„	17	...	425,000
	89,872				£1,171,252
Native Oak Bark, probably	200,000	loads at	£14	...	2,800,000
					£3,971,252
Larch Bark in Scotland, about	50,000	„	£5	„	250,000
			Total	....	£4,221,252

The following gives the quantity and value of the exports of leather goods of British manufacture in 1870:—

	Quantity.		Value.
Leather..................cwts.	102,368	...	£852,910
Boots and Shoes...... pairs	4,447,836	...	1,143,192
Leather Wrought, other sorts.....................lbs.	1,392,896	...	299,559
Saddlery and Harness, declared value	......	...	326,711
	Total...........		£2,622,372

Before foreign Commerce had increased so rapidly, and Science had made those surprising discoveries which have greatly benefited the arts and manufactures, it was anticipated by old tanners of leather that if the trade and consumption increased at the ratio it was then doing, a great deficiency of indigenous bark would become manifest, and the price would some day reach £80 the load. This fear, however, has proved groundless, for, although during the great war it advanced at one time to about half that price, yet it has only since reached £22 the load, and of late years has not varied to any considerable extent in price, £12 to £18 being about the extreme rates. The price is now lower, because the increasing use of other tanning materials makes the tanners less dependent on the supply of English oak bark.

The uses of leather are so numerous that it is somewhat difficult, without precise official returns, to form any correct estimate of the aggregate consumption and value. If we allow half the population of the United Kingdom—say 15,750,000 persons—to use

only two pairs of shoes each per annum, and calcul these at but 5*s.* per pair, we get at a money value fo this single article of £7,875,000. This sum migh however, be safely doubled. Then there are numberle other uses of leather;—it is largely employed fo straps or belting in driving machinery, for saddle and harness, fire-buckets and hose, portmantea gloves, bookbinding, hangings, &c.

Although there have been some substitutes intro duced—in the shape of American cloth, india-rubb and gutta percha—there is, after all, "nothing li leather" for all general purposes, whether regard had to quantity, durability, or cheapness.

Parchment and vellum, made from the skins of t calf and the sheep, are also employed by law writ to engross deeds on; for bookbinding, drum-hea and other purposes. Kangaroo skins have lately co into commerce for gloves and boots; and many tho sands of the dry hide of the gnu are now brought from the Cape.

To summarise the Leather Trade interest, we ma fairly take the following figures as tolerably accura for a superficial enquiry:—

Plant of Tanneries	£500,000
Value of Tanning Materials employed	4,000,000
Value of Hides, &c., imported	6,500,000
Do. from Home slaughtered animals	5,760,000
Exports of Leather Goods, British made	2,623,000
Leather Goods, Gloves, &c., Imported	1,400,000
Leather Goods made and used at home, say	10,000,000
Total	£30,283,000

NEW PAPER-MAKING MATERIALS, AND THE PROGRESS OF THE PAPER MANUFACTURE.*

THE subject which I bring before the Society this evening is one of much importance, in which we are all more or less deeply interested. There can be no question of the great value of paper as a means of diffusing knowledge, awakening thought, calling forth invention, and civilising the world. It is the handmaid of all arts, of all sciences, and of all trades. Both in an educational and a commercial point of view, an extensive supply of paper, at moderate prices, is of national interest. The laws of supply and demand will, indeed, regulate the question, but discussion and circulation of opinions may result in extended benefit to the paper-maker as well as to the reading and writing public.

The technical question of what is paper, what are the materials of which it is composed, may well be raised, for it led to a trial, some years ago, between the Excise and a paper-making firm, the Attorney-General v. Barry. In the edition of "Johnson's Dictionary" published about the middle of the eighteenth century (1755), paper is defined as "a substance on which men write and print, made by macerating *linen* rags in

* A Paper read before the members of the Society of Arts, Manufactures and Commerce, January 25, 1871, and published in the Society's Journal, vol. xix, p. 171.

water, and then spreading them in thin sheets." "Webster's Dictionary," of our own day, enlarges the list of materials, and describes it as "a substance in the form of thin sheets, or leaves, intended to be written or printed on, to be used in wrapping, &c. and made of a pulp obtained from rags, from straw, from bark, or like materials, pressed and dried."

An historical fact which was brought before this Society twenty years ago, by Dr. Crace Calvert, may be again noticed here. It is that paper, made from the papyrus plant, had lasted 1,822 years before the Christian era to the eighth century. Egypt was invaded by the Arabians and her trade destroyed. It was then, for the first time, that cotton paper was imported from China by the Arabians, who, two or three centuries afterwards, supplied us through Turkey. The manufacture of their flax paper was so successful that cotton paper was completely laid aside until the commencement of the present century, when once more it expelled from the market the linen paper.*

* Mr. Thomas Wright, in a letter to the "Athenæum," says: —I have made a little discovery, which I think will be considered curious in the history of paper. I believe that the first traces of the use of paper in Western Europe are found towards the end of the twelfth century, and we have no reason to suppose that it was in use in England until the thirteenth, or even the beginning of the fourteenth. It is understood to have been brought westward from Italy, where it was in use earlier; and I believe that our word *paper*—a corruption, of course, of *papyrus*—is considered to have been borrowed, with the article itself, from the French. I saw years ago in Paris—I believe they belonged to the royal collection (it was in the time of Louis Philippe)—a few of the earliest documents on paper known, belonging to Western

Our word "book" is said to have come from the Gothic word for the birch-tree, some part of which, probably the liber, or inner white rind between the bark and the wood, may have been the most convenient substance which nature has furnished in the northern

Europe in the period since the Romans, which interested me much. They consisted of receipts, or rather bonds, for money borrowed from the Jews in the time of our Cœur-de-Lion, given by chiefs who were starting for his Crusade; and, if I remember well, the paper resembled much that of the fifteenth and sixteenth centuries, except that it was of a rather coarser texture. It would seem as if, in the West, its use at this early period was known principally among the Jews. Now, I am just passing through the press an edition of a glossary of Latin and English—or, as we are accustomed to call it, Anglo-Saxon—words, of, I think, not later than the middle of the tenth century. We may safely look upon it as the English of the days of Athelstan; and in the part of which I have just received the proof I find "*Papirus*, paper." The word *paper* does not occur in Dr. Bosworth's, or any other, Anglo-Saxon dictionary; but we have here evidence that it was in use in our language at a very early period, and there cannot be a doubt that we derive it from the Anglo-Saxons, and have not taken it from the French of the Middle Ages. But this fact leads us to another—namely, that our Anglo-Saxon forefathers, to have the word in an Anglo-Saxon form in their own language, must have been pretty well acquainted with paper itself, and, no doubt, they found the Roman paper in use in the island when they came. It is a fact, indeed, which opens to us several others, equally new, in the social history of our Anglo-Saxon forefathers. I need hardly add that paper probably never went entirely out of use in Western Europe after the Roman times, and a little research might still throw some curious light upon its history during the earlier Middle Ages. It certainly was not supposed before that it might be in use among the Anglo-Saxons.

parts of Europe for portable documents. Other substances than of vegetable origin may be written or printed on, of which we have familiar instances in the present day, in our slates and lithographic stones copper and steel plates, parchment and vellum, gelatine paper, silk play-bills. In olden times, characters, too, were engraven on stone, or impressed in clay, dried and hardened, as the Babylonian bricks; boards of wood covered with wax, plates of ivory and metal, and the leaves of palms were used. The Chinese, Japanese, and Indian papers are made without rags, consisting chiefly of bamboo, the paper mulberry, and other macerated barks and fibres, and their celebrated rice paper, so long a mystery, is now known to be made from the cellular pith of the *Aralia papyrifera.*

Among the influencing causes for the greatly increased demand for paper are the removal of the excise duty on manufactured paper and the stamp from newspapers, the extended number of daily and other journals issued at a cheap price, and the large editions of these called for, owing to the eagerness to obtain intelligence. The increasing commerce of the country must not be lost sight of, and the extensive home and foreign correspondence resulting therefrom, some 700,000,000 letters passing annually through the post. Educational progress also leads to more writing, reading, and book-printing. We have also to remember how many other uses paper subserves, as wrapping material, for card-board, *papier-mâché, carton-pierre*, &c.

Building paper now forms a regular article of commerce in the United States, and more than one public company is doing a large business in it. It is used on the outside of frame buildings, and under shingles and

floors, to keep out the cold, and on the inside instead of plastering. It is said to be both warm and cheap. Paper tiles are also used in Saxony for roofing sheds, stables, and barns; and paper collars and other articles of dress have long been in use.

[Since this lecture was delivered another important application of paper pulp to industrial purposes has been brought into extensive use in curtains, &c., which were largely shown in the Paper Section of the London Exhibition for 1872. To a casual observer these curtains appear to be very elegant *cretonnes* from Mülhouse, or chintzes from Manchester, but a closer examination shows them to be composed of a very different material. To the eye they are cotton goods, to the touch paper, whilst in reality they are neither, and yet are a combination of both. They are in fact manufactured from a felted fabric or *tissue feutre japonais*, as M. Eugène Pavy, the inventor, terms it. The fabric is not a real tissue, but rather a species of Japanese paper of very strong texture. It is firm and tough, while at the same time it is pliable, and is capable of being applied to many of the decorative and industrial purposes for which paper and cotton goods, and even leather, are at present used. Its great recommendation is that by its aid the most elegant fabrics can be approximately and serviceably imitated, whilst the cost to the public does not exceed one-tenth that of the articles which it supersedes. The manufacture has taken a wide extension, and is now carried on by Pavy's Patent Felted Fabric Company, Limited, Hamsell Street, London, the works being at Chilworth, near Guildford.]

When we consider that 550,000 tons of cotton,

125,000 tons of jute, and 130,000 tons of flax and hemp, were imported and worked up in 1869, besides 53,000 tons of home-grown flax, one would suppose there ought to be a great deal of the waste of these fabrics available for the paper-maker. But among the minor tendencies of industries few are more noteworthy than that shown in the increased utilisation of waste materials. As competition becomes sharper, manufacturers have to look more closely to those items which may make the slight difference between profit and loss, and convert useless products into those possessed of commercial value.

Our manufacturers have not been slow to appreciate this truth, as is shown in more than one branch of trade. Thus, the refuse blowings and droppings from the spindles and looms of cotton-mills, which were formerly available for the paper-maker, are now found to possess a high textile value, and form the basis of a distinct branch of trade. Millions of pounds of this waste cotton are now used annually in the fabrication of wadding, common carpets, twine, &c. There are a hundred opportunities among the staple industries of the country to secure an equal economy and profit, by turning to proper uses residues and substances now disregarded and thrown away as waste.

In the manufacture of paper, as well as in all other mechanical industries, there has been great progress made, even in the last half-century. Chemistry and Mechanics have each contributed their part. The former has afforded us improved methods for washing, bleaching, and colouring the paper stock, which must yield a different product from what was made by the ancients. The mechanical improvements, too, have

been many, both for boiling and running out the pulp. The use of ultramarine, which was at one time almost as valuable as gold-dust, has been so extended and cheapened by the labours of the chemist, that its artificial manufacture must be regarded as one of the triumphs of modern science.

Chemistry has also taught us that the cellulose of all plants is the same as that contained in rags, and that, in fact, the fibre of some plants will give us a paper that cannot be made from rags. Not all plants, however, are adapted to the making of paper. Much depends upon the bark, membrane, and fibre, and there is a difference in the purity of the cellulose in various plants. Chemical tests also show a modification in the fibre of plants. The cellulose of cotton yields a blue colour immediately, with tincture of iodine; that of flax does not turn blue until an acid has been added, and hemp requires both acid and considerable time before the blue colour makes its appearance. These reactions point to the presence and absence of starch and glucose in different species of plants.

The removal of the excise duty on paper, which took effect in the year 1861, renders it difficult to ascertain with any precision the quantity of paper now made in the kingdom, but we may form a fair estimate by looking at the progress under the duty rate, and judge of the advance from the incentives and stimulus to increased production. The following are official figures of the quantity of paper charged with duty :—

1842	lbs.	96,693,399
1852	„	154,469,211
1861	„	229,502,864

From which we may fairly estimate the present production at 300,000,000 lbs.

Our shipments of paper scarcely keep pace with the increased production and home consumption, which may be attributed to foreign competition, and the colonial paper mills now established in Canada and Australia. The exports are officially given as follows of British paper of all kinds :—

	Quantity.	Value.
1860	cwts. 112,514	£450,589
1865	„ 141,075	447,741
1870	„ 177,683	530,646

The exports and home consumption compare as follows, in lbs. weight :—

	Exports.	Consumption.
1849	5,966,319	126,166,341
1859	20,142,352	197,684,847
1869	24,014,592	276,000,000
1871	25,688,000	300,000,000

In 1870 our export of paper of different kinds, including paper-hangings, was valued at £643,015, and in 1871 at £669,923, besides £531,934 stationery other than paper. The quantity of foreign-made paper received has been annually increasing of late years. In 1869, 412,900 cwts. were imported, valued at £690,547, of which 49,920 cwts. were re-exported. In 1871 the foreign imports were of the value of £685,276. The following are the imports of foreign-made paper of all kinds in cwts., in the three years ending 1869 :—

	1867.	1868.	1869.
Printing	174,429	177,220	169,275
Other kinds	151,925	193,387	243,626
Paper-hangings	7,753	5,660	4,435
Total	334,107	376,267	417,306

Besides these foreign imports, we have to consider the quantity of paper used for paper-hangings. The home consumption under this head I can form no estimate of, but give the exports. In 1858 these were stated at 15,000,000 yards, valued at £74,649; in 1869, the official returns gave the quantity of paper-hangings exported at 46,617 cwts., of the value of £132,635.

Many of the cheap foreign-made papers contain upwards of 30 per cent., or nearly one-third of their weight, of fine white clay, and are but films of mineral matter, held together by a few fibres interpolated, which must, ere long, from their rottenness, go to pieces. Even our own paper-makers are not free from blame in this adulteration. It was drawn prominent attention to a few years ago, in a work on Paper Manufacture, by M. Van den Corput, of Brussels, and more recently in the report of the jurors on Paper at the Exhibition of 1862. From this depreciation in the quality of our paper, doubts have been expressed whether or not our books and deeds will outlive their writers. The cause of this deterioration seems to be in the use of a large amount of sulphate of lime, to give the paper a good colour and a seeming firmness of texture. The result is that our books, some of which are called "standard," are falling to pieces, and deeds, which were intended to be permanent exponents of their writers' wills, are now so faint as scarcely to be legible. Paper of a good quality ought not to leave, after burning, more than 2 per cent. of ash, and the best Swedish filtering papers scarcely any ash; but it is very common now to meet with papers which contain one-third or a quarter of their weight of silica and

clay, so that they might almost with propriety be called mineral papers. Ten years ago it was estimated, by one of the best authorities, that 60,000 tons of kaolin, or China clay, were used in the paper mills of Europe in the place of rags. Kaolin is now a very extensive ingredient in paper-making, and the Cornish clay merchants prepare it specially for paper-makers, and advertise this in the trade organ.

The paper-makers' licences, granted during the time of the duty, afford some idea of the briskness of trade, and the paper mills at work. I find the number of mills rose from 408, in 1785, to 800 in 1829 (the highest number reached). They then declined annually until 1852, when there were 400, at which, with variations of some 8 or 10, the number has since stood. The licences granted in 1869 were 326 in England, 60 in Scotland, and 22 in Ireland, but all the mills were not at work, and within the last year there have been still further reductions in the number. The "Paper Mills Directory" for 1871 gives the number of paper mills in working order in England, in 1870, at 274, besides 12 mills not working, making a total of 286, against 290 in 1869. In Scotland there were 63 mills at work last year, against 58 in 1869. The larger number of paper mills make brown, cartridge, and such like papers; in England, not more than 100 make printing, news, &c.

If we look at a few of the latest figures regarding the publishing and printing trades, we shall see how important is the question of paper to supply the demand. There are at the present time more than 1,400 newspapers in the United Kingdom, of which 110 are

daily, of these 61 are published at one penny, and 34 at one halfpenny each. The magazines and reviews number 626. The quantity of paper which all these require it is impossible to calculate; but when we find that one London daily paper asserts its average daily circulation to be upwards of 190,000 copies, and if we assume the other London dailies to have each but half this circulation, we can form an idea of the enormous demand for paper, even in the metropolis. Besides the political journals, some of the literary, religious, sporting, and other publications have very large circulations. But we have also to take books into consideration. According to the "Publishers' Circular," last year there were 4,656 new books and new editions published in Great Britain. In the United States about half this number are issued, and in Germany three times as many. This is independent of the large number of newspapers and books issued in various other parts of the globe. The make and consumption of paper in the United States are nearly as large as our own.

In 1869, we exported 59,291 cwts. of books, and imported 11,463 cwts., and the progress in ten years is shown by the figures of 1859, which were 33,915 cwts. exported, and 6,520 imported.

The price of rags mainly regulates the price of paper, for these are the mainstay of the paper-maker, although now supplemented to a small extent by crude vegetable fibres. The comparative scarcity of rags and kindred substances has rendered their supply, as a main article for paper-making, more and more inadequate, while the importation of esparto fibre from the Mediterranean countries has likewise failed to meet the augmented demand.

The import of foreign rags suitable for paper-making has increased in the last ten years by nearly 50 per cent. For twenty years it averaged about 10,000 tons. In 1858, it was 11,379 tons, value £246,133; in 1869, it was 17,000 tons, value about £300,000. The aggregate quantity of rags annually collected in the kingdom, with those imported, may be taken at 70,000 tons weight, worth at least £1,500,000. It takes 100 tons of rags to make 70 tons of paper. Notwithstanding the rags produced by our population of 30,500,000 inhabitants, added to the large quantity of jute-bagging, linen and cotton wrappers, old sails, cordage, &c., it will be seen that we are largely dependent on foreign supplies of waste materials for our paper mills. Linen rags have declined in price from £22 18*s*. per ton, in 1866, to £19 12*s*. in 1869, and cotton rags from £13 19*s*. to £12 4*s*.*

* The paper upon which the notes of the Bank of England are printed is manufactured from the whitest and best of linen rags, by one firm at Laverstoke, in Hampshire. It is made in sheets 16 inches long and 5 inches wide, each being designed for the printing of two notes; they are divided in the middle after leaving the press; therefore, every note issued by the Bank of England has three rough or deckle edges, and one smooth edge. The paper and water mark have always been the great difficulty to makers of forged notes. The engraving has been successfully imitated, so much so, that even experts have been deceived by it; but spurious paper has never, up to the present time, stood the test. A quantity of paper, enough for making about 990,000 notes, is forwarded to London once a month; it is delivered to the bank-note paper office, where it is counted, and then handed to the printing-office. After passing through a machine which prints all but the numbers, dates, and signatures, it is returned to the paper office; in this transition state it is kept in store; as notes are required, it is again passed through a machine for completion; each sheet is then cut in half, as before stated,

The average value of the rags and other paper-making materials imported in the last two years, was about £110,000. The quantities for four years are shown in the following return, in tons:—

	1867.	1868.	1869.	1870.
Linen and Cotton Rags ...	18,497	17,860	16,980	22,209
Esparto	54,512	95,828	86,334	103,461
Other Vegetable Fibres ...	562	52	1,084	1,411
Other Materials for Making Paper	794	615	1,702	5,268
Tons	74,275	114,355	106,100	132,349

making two notes; they are counted, and carefully examined by cashiers, whose duty it is to reject all notes which are indistinctly printed, or are imperfect, for the Old Lady is very particular on this point; tied up in bundles of 100 notes each, and five of these bundles in one, making a large bundle of 500 notes. The average daily manufacture is about 37,000 notes, or 74 bundles of 500 notes: each bundle weighing 1½ lbs. The number of notes made in a year will be over 11,500,000, the paper weighing more than 15 tons. Books are printed at the Bank, with a record of every note issued. Every note presented at the Bank for payment is marked off these ledgers on the day following; the date of payment being stamped on the note and in the ledger. Should a forged note by any chance be passed, the imposter would assuredly be turned out the following day, on reference to the ledger for posting it. About 37,000 notes are presented daily for payment; they are cancelled by having the signature torn away, and two holes, the size of gun-waddings, punched through the amount in the left-hand corner of the note. Every such note is kept at the Bank ten years, and the boxes containing these notes, if placed end to end, would reach from the Bank to Kew Bridge, or more than nine miles. The authorities take pride in the fact, that should reference to any one of these notes be required, by furnishing the number, date and amount, in ten minutes it would be placed before you.

Since the discovery of a method of separating ink from printed paper, old newspapers and old books have entered largely into the paper-makers' material. And the lesson of economy should be learnt, to save for market the waste paper, instead of kindling fires with it and casting it to the winds. Let frugal housewives take a hint, and add the present wasted hundredweights of old paper to the great civilising agent of the present day. For many years it has been pointed out, in every possible way, that an endless variety of cheap materials exists in British tropical dependencies, admirably suited for paper-making, but the ever-recurring difficulty is, not where to get it, nor even what to get, but how to induce any one to bring it, or, if brought, how to induce any one to be the first to use it. This want of spirit is the dead weight which presses so heavily on the paper-manufacturer.

Owing to the increased demand, and the enhanced price of rags, it has been found necessary to employ other substances for mixing, such as, for instance, straw, esparto grass, and wood pulp. Generally speaking, and especially as regards the grasses, these auxiliary pulps, however, do not fall very far short in price of the rag product, and thus, while by such admixtures the immediate demands are met, the cost of paper remains high, and acts as a check on that expansion of the paper-manufacture which is one of the greatest and most urgent requirements of the times.

Wood pulp, chemically produced, although undoubtedly good as to quality, labours under the disadvantage of being too dear, but its production by mechanical agency, which is much less costly, may now

be considered as brought to great perfection by means of improved machinery, amongst which Voelter's system claims an undoubted superiority, at any rate in localities where the raw material is abundant enough to afford supplies for their great converting capacity, and its action is facilitated by a sufficiency of water-power. Under such conditions, each one of M. Voelter's engines of the ordinary size is capable of producing 17 cwts. of pulp daily, at a cost varying in proportion to the nature of the motive power employed, the price of the raw material, the facilities of transport, the rate of wages, and other contingencies.

In all these respects, Sweden (according to a detailed report of Mr. Gustaf Josephson) offers peculiar advantages. The supply of soft pine wood, perhaps the most suitable of all for the manufacture of paper pulp and pasteboard, is there practically unlimited, and obtainable at a price of 1½*d.* to 2*d.* per cubic foot, whereas in Germany, where a number of such works have been in existence for some time, and have supplied English markets with their produce, which is, however, mostly of inferior quality, the same material is worth about 3*d.* per cubic foot on an average. Aspen wood is likewise plentiful and cheap in Sweden.

There are now about 160 of these wood-pulp machines at work on the Continent. Some of those in Germany and Belgium, and about 30 of those situated in the Scandinavian countries, where material is abundant, send their pulp to England as a paper-material.

The first mode of preparing wood pulp from the pine and other white woods, was to reduce it into thin shavings, which were soaked in water for six or eight

days, and then dried and ground into powder by a corn or crushing mill. This powder was mixed with rags, so as to make a pulp, and the ordinary operation of paper-making was then proceeded with. The principal defect of this material was the shortness of fibre.

The preparation of wood pulp has not hitherto been sufficiently successful to make it rival rags, esparto, or straw. Further experiments may, however, go far to remove the present defects.

The difficulties which have hitherto existed in developing wood pulp were the large quantity of alkali required for disintegrating the fibre, and the necessity for very strong vessels in which to perform the operation, because it was by boiling at a high temperature with a solution of caustic soda that this could alone be performed. These difficulties have lately been overcome by Mr. F. B. Houghton, of 40, Borough Road, who recovers the alkali without evaporation or calcination. A current of gas is made to pass through the liquor which has been employed for boiling the wood; this separates the resin from the liquor, leaving it floating in it; it is then coagulated, and falls to the bottom.

Esparto, as it is called in Spain, and alfa on the African coast, is a coarse, rushy grass, which has long been used as a fibrous material for rough yarn and cordage, and more than thirty years ago was recommended as a paper-making material, but was only brought into extensive use about sixteen years ago, by the persevering efforts of Mr. Thomas Routledge. No material alteration in the machinery or apparatus is required for working esparto, and much less power is necessary.

According to a practical authority,* the successful working of this fibre depends mainly on the careful and proper adjustment and strength of the chemicals employed. The quantity of soda ash required for neutralising the gummo-resinous matters in the fibre, so as to admit of its being made into pulp, is very large, though not so great as is required for straw; and the fibre, unlike rags, never having before been subjected to bleaching or other chemical treatment, also requires very much more bleaching powder to bring it to colour suitable for printing paper. The quantities required are from five to six times as much as for cleansing and bleaching the coarsest rags.

In a late circular of Messrs. N. W. Chittenden and Co., fibre brokers, they state that, "during the past year, numerous small importations of various descriptions of fibre have occasionally been made, and ready experiments have been afforded to test their capabilities, yet none has been found as a practical substitute; and during the past twelve months upwards of 93,750 tons of esparto have been imported into the United Kingdom, and although there has been but little falling off in the importations of other material previously used, the price of esparto still keeps at about £10 per ton.†

* Mr. W. H. Richardson, "On the Paper Manufacture of Northumberland and Durham."

† A very interesting descriptive paper on "Esparto: its Cultivation, History, and the Future Prospects of the Plant," was read by Mr. Robert Johnston, before the Society of Arts, on the 20th December, 1871, and is published in full in the Society's Journal, vol. xx, p. 96. It should be carefully studied by those specially interested in the subject.

What effect this may have upon manufacturers who have been at a heavy expense in erecting machinery to work this article, when it was supposed that any quantity could be had at £6 or thereabouts, with but slight fluctuations in value likely to occur, we cannot say, but it seems an astonishing fact, that although the consumption of paper has been greater than ever, and that most raw materials from which it is produced have risen, our makers have not combined to raise the price of their production in proportion."

A correspondent, reading the discussion which took place last year, in the "Standard," on paper-materials, sent me specimens of pulp, which he had prepared in Jamaica, under difficulties, from various substances, such as the bamboo, different fibrous plants, simply crushed and macerated, and wood pulp from trees of large growth. The fibrous plants of Jamaica, he observes, are numerous, and deserve a greater amount of attention, but hitherto nothing of a substantial or permanent character has been done practically. The Jamaica papers have since taken up the subject. A recent "Kingston Morning Journal" has the following editorial remarks:—"It seems, from all we can gather, that there is a market for our fibres, and such material as they convert into pulp, if only we would set to work to produce them. There is no lack of material for this purpose. From one end of the island to the other it abounds, of various kinds, and of as various qualities. It is really pitiful to ride about the country, and see the acres of penguin that uprear their heads and spread themselves about as they can find space, preventing all other vegetation from thriving,

while it is itself practically of no use whatever, and may be regarded as an encumbrance of the ground. What a mine of wealth we have in these same penguin plants, if only people would take the trouble to set about to extract it. Years ago, the matter was talked over, and it was then set forth that the fibre is abundant, is strong, is of excellent quality for manufacture into certain kinds of cloth and cordage, while the material is as 'common as dirt' in the country. It is a pity that so little—indeed, nothing beyond the trying of a few experiments—has ever been done to turn it into practical and useful account. Besides the penguin for the production of fibre, there are the plantain and the banana plants. There is not a peasant or small settler who does not cultivate them pretty extensively. Travelling through the mountain districts, the very first things to apprise the belated traveller that he is getting within the circle of humanity, is not so much 'the watch-dog's honest bark, baying deep-mouthed welcome,' or unwelcome, as the sight of those graceful plants, waving their leafy wings in the soft night air that plays around them; and, when the village is reached, there is not a cottage but is surrounded by them; there is not a garden in which they do not abound. Then there are the fields, or 'grounds' that lie beyond the confines of home, on the higher lands, in which plantain and banana plants are to be seen also growing abundantly. These require little or no cultivation. They propagate themselves by means of the suckers that shoot out of their roots, and, except occasionally pulling the grass from around those roots, the trouble they occasion the husbandman is of an in-

finitesimal character. The plants abound in fibre of a rough character, that would be valuable in the manufacture of cordage, while the pulp might be converted into paper of a coarse description. All the use that is made of the plant at present is to cultivate it simply for the sake of its fruit. The other portions of it are thrown down, and lie on the ground and rot. There is some singular fatality attending this country, that so much that is useful, so much that is really valuable, is allowed to grow up and then to rot, when it might so easily be converted into money."

The paper-yielding stems of the plantain and other indigenous plants have been too long neglected. Useful and tough kinds of paper have been made from them. Simple pressure between rollers and washing would appear to be sufficient for the separation of the fibres of most of them.

A Jamaica correspondent sent me by the last mail a copy of a Kingston paper, which reports that the Governor, "Sir John Peter Grant, is turning his attention to the development of the fibrous wealth lying latent and running to waste in this island. In plainer language, his Excellency thinks there is money to be made by preparing for market the numerous varieties of plants growing without cultivation all over the country, from which fibrous materials may be extracted, for the manufacture of cordage, textile fabrics, and paper; and we learn that he is about to bring to this country a person experienced in the extraction of fibres from the plants containing them, if not for the further conversion of the materials so evolved into manufactured articles. At present, we do not go so far as to insist

on the manufacturing part of the project, but we would content ourselves just now with an impetus, such as it is said Sir John contemplates, to the growth and preparation of the raw material for the purposes of the manufacturers of Manchester, Glasgow, and other towns and places in the United Kingdom. We are not so ambitious as to 'despise the day of small things.' Therefore, for the present, at least, we should be quite satisfied to witness the shipment of a few tons of raw material spoken of, by way of a beginning to a new industry which, we are convinced, if followed up with spirit, is calculated to provide a handsome living, if it do not lead to affluence, to such persons as may engage therein, provided that they set about the work understandingly, and carry it on skilfully, and at the lowest possible cost. Nor does it appear to us that any very elaborate process, involving complicated and costly machinery, is absolutely necessary for the purpose of separating from fibre-producing plants, such as we have in such luxuriant abundance in the island, the ligaments, which form their strength and real substance, from the feculences which keep them together in a state of cohesion. Now, the Jerusalem dagger, as well as the common dagger" (these I believe to be *Yucca gloriosa* and *Aloefolia*), "grow luxuriantly all over the island. In regard to the latter, it is too common to render necessary one word about it. The other variety is not so well known. The leaf is more soft and pliable, and seems to us to be more adapted to the manufacture of cordage, and perhaps for textile fabrics, than the better-known kind. We can assure our readers, and we now address ourselves more par-

ticularly to those abroad, who are in any respect interested in spinning and weaving—that the fibre of the two plants we have already named requires no bleaching—at least it seems so to us; for immediately it is cleaned, washed and dried, it is as white as the best bleached linen thread, and much whiter than the printing paper on which this article has been written. Nor this alone. It is as fine as the finest silk as it comes from the worm, tough, and elastic. Unlike the plantain fibre, which breaks if made into a knot, it is tenacious, and can bear any complication of knots without snapping. This is one of the greatest desiderata in all fibres, whether for cordage or textile purposes. Then, if we mistake not, whatever substance is suitable for cordage and woven fabrics is equally suitable for manufacture into paper, with this advantage, that, for the latter purpose, the waste and refuse, embracing short, broken fibres, may be used with equal benefit to the long, sound fibre employed for the other purposes named. We may add, that the paper-manufacturer will be able to turn out a superior article, because he will have for stock a raw material much stronger than the old rags he has been in the habit of employing in his manufactory. We have already alluded to the marked whiteness of the fibre of the dagger. In this, as well as in its greater flexibility and tenacity, it is far superior to the fibre of the plantain or banana of any description, which would require considerable bleaching for either paper or any of the textile fabrics."

The bamboo is not a new paper-material, although it has only recently been introduced into this country for

that purpose. Much of the common Chinese paper is made from it, as may be seen described in Herring's work "On Paper," p. 31. The American paper-makers have for some time obtained supplies from British Guiana, Jamaica, and other parts of the West Indies. In a paper which I read before this Society two years ago,* I called attention to what the Americans were doing with bamboo as a paper-material, and this seems to have led to shipments here of this gigantic grass.

During last year, some supplies of a very excellent new material were imported from the Portuguese settlements on the West Coast of Africa, where considerable quantities may, it is said, be obtained. It is the fibrous bark of a Sterculiaceous tree, the baobab (*Adansonia digitata*), and, from its tough fibrous network, it would in quantity be most valuable to the paper-makers. It is not a tall tree, but attains gigantic dimensions in growth, being described by travellers as a "vegetable monster," and "behemoth of the forest," being frequently eighty or ninety feet in circumference. Dr. Livingstone asserts that nothing short of boiling the tree in sea water could possibly destroy its power of vitality. Constantly barked by the natives, the tree nevertheless retains its full vigour, and a removal of the very core or centre of the stem would not, according to that traveller, affect the existence of the tree; and "the reason is," to quote his own words, "that each of the laminæ possesses its own independent vitality; in fact, the Baobab is rather a gigantic bulb run up to seed than a tree." This

* "Journal of the Society of Arts," 1869, vol. xvii, p. 175.

tree or an allied species (*Adansonia Gregorii*) is found in the West Indies and North-Western Australia. The bark fetches readily here about £14 per ton. It furnishes indestructible cordage, and a close thread used for cloth and ropes. Ropes made from it are said to be so strong that there is, in Bengal, a saying, "as secure as an elephant bound with baobab rope."

At a late meeting of the Scottish Paper Makers' Association, the chairman urged that the attention of makers should be turned to the introduction of other materials to cheapen the cost of production, or to increase the percentage of paper yielded by the materials now in use. Wood-pulp might soon come to be more generally used, as, from recent information, there were means lately discovered, and soon to be patented, whereby the fitness of this material would be greatly improved, and its price be exceedingly moderate. An inquiry into the practicability of growing a vegetable fibre at home as a substitute for esparto was held by several Scotch paper-makers with the Chamber of Agriculture, but no definite conclusion was arrived at. The general opinion, however, was, that straw was the cheapest and best material that could be had, but great difficulty exists in obtaining large supplies, owing to the lease stipulation requiring it to be consumed on the farm. The market price of straw here being also £6 per ton above what it is in Sweden and Belgium, it can be imported from those countries cheaper than it can be bought here.

The vacoua sugar bags, which are made from the tough longitudinal fibres of the leaves of the *Pandanus*

utilis and other species of the screw pine, are a useful paper-material. 3,000,000 of these bags are made annually in Bourbon, and a large number also in Mauritius. The leaves are cut every seeond year, and each plant yields enough for two large sacks or bags. The leaves yield paper of good quality, light and strong.

In Australia attention is being directed to the utilisation of local materials for their paper mills. At the recent Intercolonial Exhibition at Sydney, in September last, a bronze medal was awarded to the local Paper Company for its brown, printing, and news-printing, made at their Liverpool mill. The brown paper was chiefly made from refuse New Zealand flax; the printing is used by the local journals. The hand-made papers, shown by Baron Mueller, of Melbourne, proved from what a great variety of vegetable fibres paper can be made, but the difficulty to be conquered is commercial,—not mechanical,—the cost of reducing much of the fibre into paper being prohibitory.

A Select Committee of the House of Assembly of South Australia reported, in August last, that thousands of tons of material, equal to any demand, and suitable to the manufacture of fibre, is growing extensively in various parts of the colony, and a large proportion on the Crown lands, while the cutting of it does not destroy the plant, but tends to improve it. The Committee report their opinion that a new and valuable industry might be opened up, not only to supply the colony with material useful for various manufactures, such as hemp, rope, and paper, but there would also arise a very large European trade. The

Committee, therefore, recommend that a bonus of £2,000 be offered by the Government for the first 500 tons produced in the colony.

Baron Mueller, in an elaborate article on the barks, foliage, grasses, rushes, &c., of Australia suited for paper-making,* remarks that forest regions and coast lines, swamps and flats subject to inundations, should prominently yield the material for the factory; for, on open pastures or otherwise occupied tracts of country, even paper-material cannot be harvested for an unlimited period, at the expense of the soil, with impunity. In factories situated in the vicinity of forests, the soda expended in paper manufactures might be profitably regained by evaporation of the ley, and crystallising it with coal or sawdust. In viewing (he adds) the immense supply of various kinds of paper-material here cheaply available, there is no reason why they should not form, closely pressed, an article of export probably less inflammable than rags; and, still more, it may safely be anticipated that, together with the consumption of rags in local factories, the new articles indicated will largely enter into the fabrication of paper, the product of Victorian industry.

I have not thought it necessary to take up the time of the meeting by an enumeration of all the Australian materials on which Baron Mueller has experimentalised, with more or less success. Many of these have been repeatedly brought under notice, others are new; but I have specimens of various papers made from them

* See my "Journal of Applied Science," August, 1870.

here, for the inspection of those interested. These papers have not been subjected to chlorine, or drawn through size.

In the reports of the jurors at the New Zealand Exhibition of 1865, it is stated that New Zealand produces a number of fibrous plants and grasses suitable for the manufacture of paper, a branch of industry which must, at some future time, become an important one. The bountiful supply of pure water with which almost every portion of the colony is blessed, and the facilities which exist for the erection of mills to be driven by water power, combined with the abundance of paper-making material, which grows in profusion throughout the colony, constitute New Zealand as *par excellence* a favourable country for the production of paper for local supply and for the other Australian colonies. With regard to paper-making material, the *Phormium tenax* must again occupy the first place. Not only is the fibre admirably suited to that purpose, but it is the more valuable, inasmuch as the refuse particles of fibre, after its preparation for spinning, are available for the manufacture of paper. In the event of the cultivation of the *Phormium tenax*, there will always be a large quantity of damaged, and what would be otherwise waste leaves, valuable to the paper-maker. Forty years ago, paper was made of it to print an edition of a work by Mr. John Murray, of Edinburgh, on the plant and its uses. The peculiarity of this paper is its tenacity, which property should make it important for documents and printing to stand a great deal of wear and tear.

No better paper could be used for bank notes, or for the printing of valuable standard works.

Twenty-five years ago, it was shipped from the colony as a paper-material in solid lumps, to lessen freight. The paper obtained from it is the strongest of all. The subject, from that time to the present day, has been one of almost constant discussion. The readiness with which the large richly-fibrous leaves can be turned into pulp for a very substantial paper, entitles the plant not alone to consideration, but also the fact that it may be permanently established with the greatest ease in any swampy ground.

Many of the native grasses of New Zealand are sufficiently fibrous for the manufacture of paper, and the profusion in which they grow on almost every variety of soil, and under every condition of the climate, is an additional reason why efforts should be made to utilise them. One variety of grass in particular claims attention, from its resemblance in many important features to esparto; this is the "snow grass," one of the tussocky grasses of the colonists (*Schoenus pauciflorus*, Hooker), which grows rank and luxuriant at high elevations and on barren soil, in the interior of the Middle Island. Experiments have been made at Dunedin as to the paper-making qualities of this grass, and the trial was sufficiently satisfactory to establish its value for the purpose. But while I direct attention to these paper-making materials, I fear Australia is too far distant to be thought of for any extensive supply of raw material for our paper mills, and we must look to nearer quarters, such as the shores of Northern and

Western Africa, Brazil, Central America, and the West India Islands.

Seven or eight years ago, in a work which I published on the Utilisation of Waste Substances,* I suggested that the woolly fibre adhering to the hulls of the cotton seed might be economised in the manufacture of paper, and I am glad to find that this, like many other hints then thrown out, has since been carried into practice.

At the last meeting of the British Association a paper was read by Mr. Thomas Rose, of the firm of Rose and Gibson, of Sankey Mills, Earlestown, on the further utilisation of cotton seed, and especially by converting the short cottony fibre adhering to the husk of the herbaceous cotton, and the husk itself, into paper. The seed yields, in round numbers, 50 per cent. of kernel and 50 per cent. of fibrous husk. The kernel yields about one-third crude oil and two-thirds cake. The fibrous husk gives an average of 30 per cent. pure fibre. The process of operating is this, the cotton seed is fed between a pair of rollers, running at differential speed, and not quite in contact. This cracks the husk or shell, and allows the solid kernel to fall out and be easily separated. A system of riddling further separates a great deal of the dry, broken husk. After this it is boiled in caustic soda, in a revolving boiler, by which means much of the remaining husk is got rid of, and final washings so completely liberate the cotton that it is ready for bleaching. After this process it is reduced to pulp,

* "Waste Products and Undeveloped Substances." London: R. Hardwicke, 1862.

and converted into paper. Supposing this to prove a success commercially, of which Mr. Rose (who is now in America on the subject), appears to be sanguine, it will further utilise a waste product on which I have often spoken in former years in this room, and add something to the means of the paper-maker as regards raw material.

In a late number of the "New Orleans Picayune" (November 10, 1870), I find an article giving elaborate statistical calculations about the value of the cotton seed and its subsidiary products; but I am a little sceptical as to American estimates and figures, particularly when the aggregate money value of the oil, oil-cake, and ashes of the hulls as a fertiliser, are set down at the large sum of £11,000,000 sterling, or equal to one-fourth of the value of the incoming crop of cotton. The quantity of cotton seed from an American crop of 3,000,000 bales is represented to be 2,250,000 tons. Now, sharp as our American cousins are in turning matters into money, they do not appear yet to have thought of utilising the fibre. If this is all woolly-seeded cotton, the weight of seed spoken of ought to yield about 300,000 tons of pure fibre, worth, to paper makers, not less than £7,500,000; and this is quite irrespective of the bark of the stem of the cotton plant, which I have not yet heard is economically used.

Looking at the utilisation of this small cotton-seed fibre, I see no reason why another material should not be available, in the fibrous husk or covering of the betel-nut of India (*Areca catechu*), which is in such general use throughout the East. The fibre has a soft

and cotton-like feel, and is capable of being spun into twine. Immense quantities of these husks are now thrown away, and, as a paper-material, they ought to be collected in large quantities and at little cost. From Ceylon, about 70,000 cwts. of these nuts are shipped annually, and large quantities from Penang, Sumatra, and Travancore, and from other quarters, there are also large exports.

The leaves of many palms, but chiefly of the dwarf palm (*Chamærops humilis*), *Phœnix spinosa*, and other species, have lately been imported for paper-making, and are found useful if well separated from the leaf-stalk, which is hard, stiff, and brittle.

A patent has lately been taken out for applying the creeping stem of the antidote cocoon (*Feuillea cordifolia*) as a paper-material. This is a cucurbitaceous, perennial, scandent plant, climbing on the highest trees, very common in Jamaica.

It has been well remarked that it is from a careful observation of the laws of vegetable growth and decay that man has been enabled to take advantage of many of the beautiful vegetable products that lie scattered about in luxuriant profusion, and in proportion to the pains he takes to observe the laws of nature, and the judgment he displays in applying this knowledge to scientific or useful purposes, so are the results beneficial to the community at large. One man looks perhaps at the chemistry of vegetables, another merely at the physiology, while a third considers it useless to waste time with such abstruse studies, and enquires merely what is the mercantile value of fibrous substances, and how cheaply they can be brought into

the market. Now, all these enquiries have their relative importance.

In this superficial investigation into paper-making materials, I have merely touched upon a few of the more prominent, without going into practical details, which can best be supplemented by those present who are specially engaged in the manufacture. The subject will not have been introduced in vain if any of the facts or suggestions I have brought forward shall result in benefit to those who are more especially occupied with and interested in paper-making.

ON NUTS, THEIR PRODUCE AND USES.*

THE subject on which I propose to address you may at first sight appear somewhat trivial and unworthy the notice of a scientific society. What is there, it may be asked, in nuts, of interest, commercially or scientifically, that merits attention or consideration which is not generally known? But I think, before I have concluded, I shall be able to remove any such superficial idea, and to show how large a part nuts play in the roll of commerce, and how important are the uses of their several products, as evidenced by the fact that we pay more than £3,500,000 yearly for nuts and the products of nuts.

But first it is necessary to define what a nut is; and here I fear we shall meet with numerous conflicting opinions. In the popular sense of the term, it would probably be described as some seed with a hard shell enclosing a kernel; but then chesnuts and other thin-shelled fruits vary the idea. The strict botanical designation would probably be a fruit consisting of a hard pericarp surrounded by bracts at the base, of which the acorn and the filbert are examples. The

* Read at the evening meeting of the Society of Arts, April 24th, 1872. Professor R. Bentley, F.L.S., in the chair. For this paper the Council of the Society of Arts awarded their Silver Medal.

seed-vessel enclosed within an involucre or husk of the cultivated hazel nut, is of the same nature as the cup of the acorn, and the prickly case in which the nuts of the chesnut and the beech-mast are enclosed. Most probably my learned friend in the chair, if asked to define a nut, would state it to be synonymous with a gland, an inferior, dry, hard, indehiscent, one-celled, one, or rarely two, seeded fruit. It is also applied to a superior fruit, by some botanists, of a similar character in some respects to the above, as in the cocoa nut. Nut is also applied to such fruits as those of labiate and boraginaceous plants, which are properly "achenes," and defined as a dry, one-celled, one-seeded, indehiscent fruit, with a hard covering. Willdenow's definition was, "A seed covered with a hard shell which does not burst." N. Bayley's Dictionary, revised by Dr. Scott, and published in 1764, defines a nut as "A fruit or kernel included in a shell, or a seed included in a brittle but not stony shell; if the shell and kernel are in the centre of a pulpy fruit, they then make not a nut but a stone." But as I am about dealing with the subject commercially, and not botanically, I shall have to extend the range of definition very largely to take in all that are called nuts in commerce. The merchant and the broker are very lax in their designations; all, for instance, are *gums* to them, whether soluble, resinous, elastic, or mere inspissated extracts; so with many of the nuts of commerce, such as almonds, the seed of drupes, nutmegs, myrobalans, coquilla, cohune, candle nuts, ground nuts, *cum multis aliis*, which are not botanically nuts.

A variety of special dealers have certain so-called nuts in their trade.

The fruiterer and the Italian warehouseman have their edible nuts in cocoa nuts, Brazil nuts, small nuts (Spanish and Barcelonas), cob nuts and filberts, walnuts, chesnuts, peccan and hickory, butter nuts, sapucaya, pistachio, and cashew nuts, seeds of the pine cones, besides the prepared *marron glacé*, candied, burnt and sugared almonds, &c.; the grocer, his bitter and sweet almonds and nutmegs, his sassafras and Ravensara nuts; the oil broker, his ground nuts, candle nuts, palm nuts, palm kernels, oil nutmegs, bassia nuts, and others; the turner, his coquilla, vegetable ivory, cohune, betel nuts, and others; the druggist, his nux vomica, physic nut and cumara nut, or tonquin bean; the tanner, his nut galls, myrobalans, (also called gall nuts in India), and bedda nuts, valonia, or acorns and cups; even the coal merchant has his nuts, in a description of small coal so termed.

Then there are hundreds of other so-called nuts which have limited, but special uses, such as the marking nut, the clearing nut, the soap nut, and the Bonduc nut.

To some of these nuts I propose directing your attention, and although it is somewhat difficult, from the varied uses of many, to strictly classify them, I will endeavour to throw them into a few groups which shall comprise:—1. The Edible Nuts. 2. The Oil Nuts. 3. The Turnery Nuts and Ornamental Seeds; and 4, another group, which may include those of a Miscellaneous character.

The following table gives an aggregate view of the value of our imports of nuts and their products for the latest year for which the official returns are published —1870:—

		Quantities.	Value.
Almonds, Sweet	cwts.	36,189	£138,864
„ Bitter	„	6,618	20,966
Chesnuts	bushels	31,767	22,108
Cocoa-nuts..............	number	3,546,276	30,622
Small Nuts	bushels	294,236	193,452
Walnuts	„	152,681	42,638
Turnery and unenumerated Nuts		——	42,972
Ground Nuts	tons	5,845	94,419
Other Oil Nuts	„	18,033	231,123
Nutmegs	lbs.	537,970	32,510
Palm Oil	cwts.	868,270	1,583,830
Cocoa-nut Oil	„	198,602	392,657
Coir Fibre	tons	1,105	24,347
Cordage of ditto	cwts.	11,407	13,547
Cable Yarn	„	168,544	177,956
Myrobalans	„	56,610	32,928
Valonia	tons	25,718	395,546
Nutgalls	cwts.	17,748	54,169
		Total value	£3,524,754

1. Edible Nuts. The commerce in edible nuts of various kinds forms a considerable item, and furnishes a carrying trade of at least 10,000 tons. The average annual value of those sold amounts to upwards of £500,000. There are but five sorts specified in the official trade returns—Almonds, chesnuts, cocoa-nuts, small nuts (hazel nuts), and walnuts, but there are various other kinds forming articles of commerce in a minor degree, among which may be enumerated Brazil

nuts, pistachio nuts, cashew nuts, souari and sapucaya nuts, hickory and peccan nuts. Twenty years ago it was stated that the sale of filberts in Covent Garden amounted to 1,000 tons in the year, and of walnuts to 25,000 bushels. Of the quantities grown in England there are no means of forming an estimate. The imports of nuts in 1848 were—

	Bushels.
Hazel Nuts	150,022
Chesnuts	63,033
Walnuts	29,604

The progress of the import trade in these is shown by the following figures, from which it will be seen what a great advance has been made in the consumption of sweet almonds, walnuts, small nuts, and cocoa nuts :—

	1855.	1860.	1870.
Almonds, Sweet .... cwts.	24,581	19,638	36,189
„ Bitter .... „	7,366	7,361	7,618
Chesnuts ....bushels	64,756	25,218	31,767
Cocoa Nuts .... number	2,217,350	2,479,251	3,546,276
Small Nuts ....bushels	243,458	198,563	294,236
Walnuts .... „	21,949	52,090	152,681

I now proceed to give a few details as to each of these kinds of nuts :—

Hazel nuts are the fruit of the wild bush of *Corylus avellana*, unchanged and unimproved by cultivation. They seldom attain to any size in this country when left wild. The fruit differs from that of the domesticated varieties only in being smaller, while the tree is more hardy. The plant, which is a native of all the cooler parts of Europe, Northern Asia, and North America, is the parent of the many varieties of nuts

and filberts now cultivated for their fruit. The trade in "small nuts," as they are termed in the official reports, does not vary very greatly in this country, perhaps 10,000 bushels more may be imported in one year than another. The maximum never exceeds 300,000 bushels. Of 294,236 bushels received in 1870, the bulk came from Spain, 14,000 bushels from Sicily, and about 11,000 from Russia, Turkey, and other countries. Their import value is from 10*s.* to 13*s.* 6*d.* a bushel. In commerce, though both produced by the same variety, *Barcelonensis*, the nuts are classed into two kinds :—1. The Spanish, which are the nuts coming from Gijon. They will not keep any time, and are said to be coloured by the dealers with the fumes of sulphur. They arrive in bulk in small schooners. 2. The Barcelonas, which are kiln-dried, and shipped from Tarragona to the extent of 8,000 tons a year, in bags of about 128 lbs. In Russia and Turkey large quantities of fine nuts are produced of the Constantinople variety (*C. Colurna*), which are roundish and very hard. 160,000 cwts. are annually raised at Trebizond and Kuirasond. The filbert has been referred to a distinct species, *Corylus tubulosa.* The term was originally applied to those kinds of nuts which have very long husks, and in which the nut is also of a lengthened shape; but owing to the number of varieties that have of late years been obtained, this distinction, which was never scientific, appears to be nearly disregarded, and nuts and filberts are almost synonymous terms, excepting that the wild, uncultivated fruit and those varieties which most nearly approach to it are never called filberts.

The best known varieties of the filbert are the white, the red, and the frizzled. The white is the kind most commonly grown in this country. In Kent many hundreds of acres are planted with filberts, for which the county is celebrated, and whence the London market is principally supplied. As much as 30 cwts. per acre have been raised on particular lands. When quite ripe filberts will keep for several years in a dry room, and if the air is excluded, or the nuts placed in an air-tight jar, they will be sound and retain their flavour for an indefinite period. The hazel nut yields about 60 per cent. of a bland oil, which is used by perfumers.

The cob-nut of Kent is a large, roundish, prolific variety—*grandis*—of the ordinary hazel nut.

In almost every stage of its growth the fruit of the walnut tree is used. When young, green, and tender, walnuts are pickled and preserved with the husks on. About the end of June they may be preserved with or without the husks. When the nuts are fully ripe, which is generally at the end of September or the beginning of October, the kernel, deprived of its investing skin, is eaten in great quantities. As long as the skin can be easily removed, they are a nutritious and healthy article of diet; but when they get dry, so that their skins stick to them, they become indigestible.

The larger portion of the walnuts consumed in England are of foreign growth, and the imports are annually increasing, for whilst a quarter of a century ago we only imported 20,000 bushels, now we have come to require 153,000 bushels. The bulk of these

come from France and Belgium, and small quantities from Holland and Italy. Their value is much less than that of small nuts, being only 5*s.* 6*d.* to 6*s.* 6*d.* a bushel.

The albumen, which constitutes the bulk of the seed of the walnut, contains an oil which is used in large quantities, especially on the Continent. It is obtained by reducing the seeds to a pulp by means of a stone wheel and basin, and then expressing the oil, first without heat, and then by the application of heat.

In the provinces of the Peninsula where the olive does not grow spontaneously, and cannot be cultivated except in certain places having an equal temperature, as on the banks of the lakes, walnut trees have been planted from time immemorial. They yield an oil which, when fresh, is used for food and lighting purposes, or for painting when it becomes rancid. In the north of Italy, in the valleys of the Alps, and also of the Apennines, the walnut tree forms and gives its name to a special botanical region.

In Nassau and Switzerland this bland oil is much used, and is no bad substitute for olive oil in preparing salad. It is also expressed in Cashmere. The shells of the large kinds of walnuts are often mounted with hinges, as fancy receptacles for miniature articles, such as tiny wax dolls, scissors, thimbles, &c. The Limerick gloves are packed in walnut shells, whilst rings, jewels, and other small presents are occasionally disguised in this rough case as an agreeable surprise.

Our trade in foreign chesnuts, the fruit of *Castanea vesca*, is not large, and has scarcely ever reached an

import of 70,000 bushels. In the three years ending 1831 the average was 21,000, and they then paid a duty of 2*s.* a bushel. In 1842 the imports were 34,000 bushels. In 1855 the imports had advanced to nearly 67,000 bushels, but they have since fluctuated and declined. Of the imports in 1870 (31,767 bushels) about half came from France, and the remainder from Portugal and Spain. They are valued at 11*s.* to 17*s.* a bushel, those from the Peninsula being considered the best. The local consumption of chesnuts in France is said to be about 6,000,000 bushels annually. In Spain, Corsica, and the North of Italy, they form an important article of food, and serve in a great measure as a substitute for potatoes and bread. The best are those which permit of being kept good for several months. This is done by preserving them in layers of straw or in sand. In parts of France and Corsica the fruit is husked and dried.

The kernel of the Tahiti chesnut (*Inocarpus edulis*), which is kidney-shaped, about an inch in diameter, is eaten when roasted by the Pacific Islanders, and in New Guinea and the Moluccas. It is sweetish, but less pleasant than the common chesnut, harder and not so farinaceous.

The large and handsome seeds of the Moreton Bay chesnut (*Castanospernum australe*) are eaten by the aborigines in Queensland, but Europeans assert that they are hard, astringent, and not at all better than acorns. A good starch has, however, been made from them.

The almond is one of our important edible nuts of commerce. Prior to 1832 (when the duty was reduced)

the consumption of almonds here was only about 3,000 cwts.; in 1836 it had sprung up to 8,000 cwts., and now it has reached about 43,000 cwts., an evidence of the progress of commerce and the advantages of lower prices, for in 1839 the prices of the best Jordan were £9 to £10 per cwt.; Valencia, £4 to £10; and Barbary bitter, £2 10*s*. Now the best Spanish are about £6 10*s*.; other sweet kinds, £3 to £4, and Barbary bitter, £2 10*s*. The imports in 1860 were 7,361 cwts. of bitter almonds, and 19,638 cwts. of sweet almonds. In 1870 the imports of bitter were about the same, but of sweet the quantity was 36,189 cwts. The Valencia almonds are the largest and broadest in the kernel of any. The Jordans, which come from Malaga, are longer and narrower, with a more pointed kernel, about an inch long. The Barbary sweet and bitter are both small, irregular-shaped almonds. The Sicily almonds, although small, are larger and plumper than the Barbaries.

The cultivation and commerce in almonds is one of considerable importance, for the fruit enters largely into domestic and other uses, forming a principal ingredient in cooking, medicine, and trade. The Provence almonds of France are soft shelled, sold ordinarily in the shell; the "Princesses," consumed in France, Belgium, Holland, Germany, and Russia; the "Ladies," sent chiefly to the United States; wavy almonds, which keep the best, and realise double the prices of the ordinary varieties: these are principally employed in confectionery, as burnt almonds, and for fine pastry. The bitter almonds are used in the preparation of liqueurs, macaroons, and different medicinal

compounds. A bland oil is expressed from almonds, which is used in medicine. It is obtained alike from the sweet and bitter varieties, and is of the specific gravity ·915, of a pale yellow colour, but becomes colourless when long exposed to the light. It soon grows rancid. It is so plentiful that 5½ lbs. of almonds have yielded 1 lb. 6 ozs. of oil by cold extraction, and ¾ lb. more on heating them.

The Brazil nuts of commerce, called castanhas in Brazil, are the seeds of *Bertholletia excelsa*. About twenty of these nuts are contained in cells, within a hard spherical capsule. They form a delicious fruit when fresh, and also yield a large quantity of oil. 1 lb. of nuts will afford 10 ozs. of a pleasant, bland, clear, yellow oil, which might be furnished in abundance to the markets of the world. It has a great tendency to change if kept, but is used for culinary purposes when fresh. About 90,000 bushels, valued at £36,500, are annually shipped from Para, and they arrive in bulk in small schooners. The first arrivals will often fetch about 42*s*. per barrel of 3½ bushels.

The nuts in the drupe of the *Pistacia vera* and its varieties, natives of Syria, are imported in small quantities here, shelled or unshelled. The pale green kernels have a flavour like sweet almonds, and are used as a dessert fruit in cooking and in confectionery. Although they are not now enumerated in the Board of Trade returns, in 1855 we imported 3,210 cwts. of these nuts. The imports are, however, much less than this now. On the Continent and in Turkey pistachio nuts are much esteemed. From Aleppo the exports

are about 1,300 cwts. yearly. One of our large West-end perfumers (Piesse and Lubin) makes large use of the pistachio nut for its meal, much recommended as a substitute for soap, and pistachio oil for the hair, which is said to be used in Spain for the raven tresses alike of the mountain peasant and the court beauty; and a powder and milky emulsion for the complexion are also made from it.

Pine seeds are eaten in very many countries. Those of the stone pine (*Pinus Pinea*) are largely used at dessert with wine in Italy, under the name of pine nuts. They are brought to market at Lisbon, strung upon threads like beads, and suspended upon a girdle round the waist. The seeds of Lambert's pine, in North America; of Llave's pine, in Mexico; and of Gerard's pine, in Thibet and Affghanistan, are also edible when fresh. In Switzerland the seeds of the Siberian stone pine are used in some places as food, and in others as an article of luxury. The shell being very hard, and requiring time and skill to separate it from the kernel, the operation forms an amusement for some persons in the long winter evenings. The pinones of the imbricated-leaved pine of Chili are a chief article of consumption among the Indian tribes. As the seeds will keep long they are often imported into the southern districts of Chili from the Cordilleras, and when boiled are eaten by the country people either hot or cold. The seeds are buried in pits by the Indians for winter use. Another species of *Araucaria*, whose fruit is called Bunya-bunya by the natives, forms the principal article of their food in Northern Australia. The cone is very large, 9 to 12 inches in length by

9 inches in diameter. The seeds, which are readily shed, are from 2 to $2\frac{1}{2}$ inches long by $\frac{3}{4}$ inch broad, sweet before they are perfectly ripe, and after that resembling roasted chesnuts in taste.

The large seeds of the cones of *Pinus Fremontiana* of the Rocky Mountains, constitute from their abundance the principal subsistence of the Indian tribes.

The nutmeg may, perhaps, be included under the edible nuts, as it is an important article of commerce. In the four years ending with 1841 the average import was only 121,000 lbs. In 1850 it had risen to 312,418 lbs., and now the import and consumption is 538,000 lbs., worth 1*s.* 6*d.* per lb.

Formerly the production was a monopoly of the Dutch East India Company, and although the cultivation has been attempted in other quarters, it only succeeds in the Straits Settlements and the islands of the Eastern Archipelago. In the Banda Islands the produce is about 530,000 lbs. annually (in 1847 it was as much as 755,000), and all above that quantity used to be rigorously destroyed. The collected nuts when ripe are dried in the sun or by the heat of a moderate fire till the shells split. They are then sorted and sometimes dipped in lime water, to preserve them from the attacks of insects. The shape of the nutmeg varies considerably, being spherical, oblong, and egg-shaped; but the nearer they approach sphericity of figure the more highly are they prized. Those of good quality should be nearly round, heavy, weighing on an average a quarter of an ounce. The broken nuts are made to yield, by expression or boiling, a concrete oil, termed nutmeg-paste or butter, which

is used for flavouring. Its specific gravity is about ·948. What is erroneously termed oil of mace is obtained by distillation from the nutmeg, and should bear its name.

The long (wild or male) nutmegs of commerce are the produce of *Myristica tomentosa*, and are not so much esteemed as the round.

The cashew nut (*Anacardium occidentale*) is another tropical fruit, occasionally imported for its sweet kernels, and which has this peculiarity, that the nut is attached to the fruit, instead of growing within, as is usually the case. A thick, black, oily, viscous juice, called cardole, is obtained in the East Indies from the pericarp, which is a powerful vesicating agent. The white kernel, which is oleaginous and of an agreeable flavour, furnishes an oil considered superior to olive oil.

From North America small quantities of two edible nuts, the peccan and the hickory, are occasionally imported. The former is the seed of *Carya olivæformis*, the latter of *Carya alba*. An excellent oil for burning and machinery has been made from the hickory nut, in Ohio, which continues in a fluid state at a very low temperature. It is used for delicate machinery, and when properly refined would be suitable for watch-makers. The pig nut, *C. glabra*, is preferred in the manufacture on account of its thin shell and greater yield of oil, which is bitter. The oil obtained from the ordinary shell bark, and large sweet hickory nut, might come into general use for the table.

The sapucaya nut is a pleasant edible nut, which comes in small quantities from South America. The

fruit in the capsule is suspended from the branches, and presents an appearance like small cocoa-nuts. The monkeys are exceedingly fond of the nuts.

The "cabombas," or cups of the Zabucaji or monkey pot (*Lecythis urnigera*, Martius), which contain the sapucaya nuts of commerce, are frequently of great size and excessive hardness, and are closed by a lid like that of a pyx or soap box. The aborigines of parts of South America use these not only as goblets but as pots and dishes. Hence Linnæus called the plant *Lecythis Ollaria.* The lid of the cup falls off when ripe. Portuguese turners make pretty boxes and other fancy articles out of these solid cups. In the Brazilian Court, at the London Exhibition of 1862, some handsomely-carved and mounted specimens were shown.

The butter nut, or Souari nut, is the fruit of *Caryocar tomentosum*, of South America. Only very small quantities are received. It yields an edible oil. The fruit of another species, *Caryocar brasiliense*, furnishes, in Brazil, the Piquia concrete oil, of a brown colour, retaining much of the flavour of the fruit.

In China and Japan, under the name of ginkgo nuts, the seeds of *Salisburia adianthifolia* are eaten.

Before passing from the section of edible nuts, I may draw attention to their various fancy uses in the series kindly shown by Messrs. Fortnum and Mason, which includes pistachio nuts and pistachio chocolates, surprise nuts, *glacé* walnuts and *marron glacés*, green candied almonds, burnt almonds, sugared almonds, and sugared nuts. And in contrast with these finished products of the confectionery trade, we have the

common almond and cocoa-nut rock of the sweet shops, for children, which sell under the curious common names of "stick-jaw" and "eggs and bacon."

2. Oil Nuts. I pass on now to a consideration of the oil-yielding nuts. I might properly speak of the olive as the principal one, for it has as much right to come into the category as some other oil-bearing seeds and fruits I shall have to allude to; but since it is never spoken of commercially as a nut, I must pass it over.

After the olive, the palm family furnish the principal quantities of oil to commerce, in those two important and well-known oils, palm oil and cocoa-nut oil. From the fruit and kernels of the oil-palm of Western Africa (*Elaeis guineensis*) we now draw our largest supply of vegetable oil. Last year (1871) 51,087 tons, valued at £1,789,000, were imported. In 1863 the palm kernel trade, then newly introduced, furnished for shipment at Lagos 2,665 tuns of oil, in 1869 20,394 tuns were exported from that port, besides 1,500,000 gallons of palm oil.

The next great source of oil from the palm is that obtained from the pulp of the cocoa-nut, and, considering the wide-spread range of this palm, it is strange that the import of the oil has made such little progress compared with its great rival, the African oil palm. One reason may possibly be that the fruit is more generally used for food, and for the refreshing drink in the nuts when young. The cocoa-nut palm is cultivated in great abundance on the Malabar and Coromandel coasts, Ceylon, the Laccadives, and everywhere in the Straits Settlements and the islands of the Eastern Archipelago.

In the West Indies, Central America, and Brazil, the cocoa-nut is extensively grown; there are groves of it for about 280 miles along the coast of Brazil, from the River St. Francisco to the Bar of Mamarguasse. From Para alone 7,500,000 cocoa-nuts, worth £130,000, are annually shipped to the United States and elsewhere.

The cocoa-nut is very widely spread over the Pacific Islands. From the Fiji Islands 500 to 600 tons of oil and 1,500 cwts. of cocoa-nut fibre are annually shipped. The trees there, however, suffered severely a few years ago from a violent hurricane, from which they have hardly yet recovered.

Many years ago Dr. Royle estimated the average produce of cocoa-nuts from the whole of Malabar at from 300,000,000 to 400,000,000 annually, valued at £50,000, and copperah, or the dried kernels, was exported for as much more. Thirty years ago there were in Travancore more than 5,500,000 cocoa-nut trees, and since that period the cultivation has largely increased, as the demand for the oil and the coir has advanced. From Cochin more that 3,000 tons of the latter are exported.

I have not alluded to cocoa-nuts under edible nuts, although the 3,500,000 imported here doubtless go to the fruiterers' shops and hucksters. They are brought principally from the West Indian Islands, British Guiana, and Honduras, and range in price from 12*s*. 6*d*. to 17*s*. 6*d*. per 100. Some small quantity of dried copperah is also imported, for the oil-presser's use. The husk forms an important article of commerce, and is readily bought by the brush makers,

being even more valuable than the nut. The quantity of nuts imported would yield about 530,000 lbs. of coir.

The products of the cocoa-nut are numerous; besides the oil, fibre, yarn, rope, matting, brushes and brooms are made of the coir from the husk; and spoons, ladles, drinking cups, and carved fancy articles from the shell.

So far back as 1857 the value of the products of the cocoa-nut palm shipped from Ceylon was £274,462, viz.:—

			Value.
Cocoa-nuts	number	1,420,856	£3,717
Coir Rope	cwts.	18,881	13,984
Coir Yarn............	„	31,652	21,364
Copperah or Dried Cocoa-nut Pulp	cwts.	20,381	12,143
Oil.........................	gals.	1,767,431	223,254

These were chiefly the produce of native plantations, situated on the south-west side of the island.

There were about 22,000 acres of cocoa-nut trees under cultivation by Europeans, which were being annually added to, but none of them were then fully in bearing.

In the ten years ending with 1869 the value of the shipments from Ceylon were—

Oil	£1,445,928
Coir......	349,622
	£1,795,550

The quantity of oil shipped does not vary much, being on the average 1,500,000 gallons yearly; but the coir has doubled in the last ten years, now amounting to 67,000 cwts., worth about £45,000, for the mere husk of the cocoa-nut.

A cocoa-nut tree, growing in a favourable soil in Ceylon, may produce from 80 to 100 nuts annually, having from eight to twelve branches, or spadices, each bearing five to fifteen nuts; it continues to bear for sixty or seventy years. The pericarp of 40 nuts gives about 6 lbs. of coir. In some parts of Ceylon the natives separate the coir by burying the husks along the borders of the extensive salt-water lakes, whence, after a few months, they are dug out very clean, the fibres easily separating from the cellular tissue of the husk. This mode of preparing the fibre prevents the offensive smell resulting from macerating the husks in water.

The following is an analysis of the cocoa-nut:—

Water	39·7
Albumen	0·5
Emulsin	1·1
Oil	29·3
Amygdalin	14·0
Sugar	3·6
Woody Fibre	9·5
Gum	2·1
Mineral Matter	0.2
	100·0

Or, in other words, the proportions in 1lb. of the kernel are:—

	ozs.	grs.
Water	6	14
Albumen		35
Emulsin		77
Oil	4	303
Amygdalin	2	106
Sugar		252
Woody Fibre	1	228
Gum		147
Mineral Matter		14

The oil is ordinarily procured by first extracting the kernel from its outer integument or shell, and boiling it in water. It is then pounded, and subjected to strong pressure. After boiling over a slow fire the oil floats on the surface. This is skimmed off as it rises, and is again boiled by itself. 14 or 15 nuts will yield about 2 quarts of oil. A somewhat different practice obtains on the Malabar Coast. The kernel is divided into half pieces, which are laid on shelves, and, underneath, a charcoal fire is kept in order to dry them. After two or three days they are placed on mats and laid in the sun to dry, after which they are put in the oil press. When the oil is well extracted by this method, 100 nuts will yield about 2½ gallons of oil. This is the method usually resorted to when the oil is required for exportation, the former when merely used for culinary purposes.

Of late years the application of steam power or hydraulic pressure for the purpose of procuring the oil has been attended with the greatest advantage in Ceylon. It is requisite that care should be taken not to apply too great and sudden a pressure at once, but by degrees an increasing force, so as not to choke the conducting channels of the oil in the press. The oil becomes solid at about 70° and has a specific gravity of ·892. It is curious that when cocoa-nut oil is first manufactured there is no unpleasant smell for the first thirty or forty hours, but after that it acquires that rancid taste and peculiar odour which no scent will entirely kill. Fresh expressed cocoa-nut oil is used by the Malay women in the Eastern Archipelago in the hair. It is perfumed by

allowing the flowers of the jasmine, tuberose, and other plants, to remain for some time in it, thus extracting and retaining the fragrant essential oil. Cochin oil bears a higher price than that of Ceylon. Poonac, or the refuse oil-cake, is sold as food for poultry and for manure; near Marseilles cows are fed on it.

The trade in cocoa-nut oil is steadily increasing at the Seychelles; fresh plantations are being laid out, and others coming into bearing. The quantity shipped in 1869 was 127,112 gallons, valued locally at about £16,000. From Penang there is an export trade in oil and copperah. Cocoa-nuts are grown in small quantities throughout the Straits Settlements, but it is only here and there that plantations of any magnitude are met with. In Java and Madura there are more than 20,000,000 cocoa-nut palms.

Coir is the fibrous rind of the nuts, with which the latter are thickly covered. There are several ways of stripping it from the husk. One is by placing a stake or iron spike in the ground, and by striking the nut on the point the fibre is easily stripped. The fibre is greatly improved in quality and appearance by beating, washing, and soaking. The tannin which this substance contains prevents the fibre from rotting. The fibre is rather difficult to twist, but coir yarn is made into good ropes, and forms the strongest, lightest, and most elastic cables for ships.

The fibrous husk of the cocoa-nut is not its least valuable product, and gives rise to a very large trade, both in the East and to Europe. At first it was much used in this country for stuffing mattresses and cushions, but its applications have been enlarged and

its value greatly increased by mechanical processes; and in a small pamphlet issued by Mr. Treloar twenty years ago, he stated that its natural capabilities having been brought out, coir has been found suited for the production of a variety of articles of great utility and elegance of workmanship, table mats, fancy baskets and bonnets. Instead of being formed into rough cordage only, and mats fabricated by hand, by means of ingeniously constructed machinery, the fibre is rendered sufficiently fine for the loom, and matting of different textures and coloured figures is produced, while a combination of wool in pleasing designs gives the richness and effect of hearthrugs and carpeting. Brushes and brooms for household and stable purposes; netting for sheepfolds, pheasantries, and poultry yards; church cushions and hassocks; hammocks, clothes lines, cordage of all sizes, and string for nurserymen and others, for tying up trees and other garden purposes; nose bags for horses; mats and bags for seed crushers, oil pressers and candle manufacturers, are only a few of the varied purposes to which the fibrous coating of the cocoa-nut is now applied. The cocoa-nut shell furnishes cups which, carved on and set in silver, are a great ornament. It is also made into small baskets, cups, ladles, spoons and other such domestic articles and fanciful ornaments. By being burnt and pulverised and prepared with other ingredients, it produces good blacking, lamp black, black paint, &c.

The fruit of the Chili palm (*Cocos chilensis*) is, in every respect, like the cocoa-nut, except that it is not larger than a walnut—about an inch in diameter. Every tree produces a great number, which are highly

esteemed, and they form a considerable article of export to Peru. A curious method is employed to free the nut from the green husk in which it is enveloped, a process that was formerly attended with a very great loss of time and labour. A number of cows and oxen are driven into an enclosure, where a quantity of the fruit is spread, and, being fond of its husk, they immediately begin to feed on the fruit, only slightly masticating it in the first instance, and swallowing the whole. Afterwards, while chewing the cud, the nuts are rejected, and when the meal is finished a heap of them is found before each of the animals, perfectly free from the husk, and thus the cattle are supplied with food at a season when little grass remains on the hills.

Before leaving cocoa-nuts, I must not omit mention of the sea cocoa-nut of the Indian Ocean, the produce of *Lodoicea Sechellarum*, or *Maldavica*.

The fruit, from floating in the sea, was known long before the plant which produces it, or the locality in which it was found, and various fables were invented as to its origin, and marvellous virtues attributed to it. The few known specimens which existed were valued at an enormous price, till, in 1745, the discovery of the Seychelles Archipelago made known the habitat and nature of this singular production. Three of the islands composing the archipelago—Praslin, Cunense, and Ile Ronde—were covered with magnificent forests of this unique palm, and their soil strewed with its huge and singularly shaped nuts. The value of their shells as domestic utensils for various purposes was at once perceived, and from that

time to the present they have supplied to the inhabitants the place of baskets, bowls, jars, dishes, measures for grain and liquids, drinking vessels, paint-pots, &c. The trees are fast being destroyed. On Ile Ronde not a plant remains. Cunense has a considerable number of fine young trees. At Praslin a great many have been destroyed by fire, and there are not perhaps a score of trees in the other islands. This palm is of very slow growth, for the trunk does not show itself till twenty or twenty-five years after the germination of the seed, and then it takes fourteen or fifteen years before it blossoms.*

I have no recent statistics of the trade in these nuts; but in 1859, 3,310 were exported, valued at £831, and 11,800 lobes or cups made of them, valued at £590. Although they have now lost much of their traditional repute, they are still held in such estimation by the negroes and poor people of other islands, that sailors always try to bring away some in their vessels. When preserved whole, and perforated in one or two places, the shell serves to carry water, and two of them are suspended from opposite ends of a stick. Some of these nuts hold six or eight pints. If divided in two between the lobes, each portion serves, according to its size and shape, for plates and dishes, or drinking cups, these being valued, like calabashes, for their strength and durability.

I have here a three-lobed nut, they are sometimes met with five lobes, and I have heard of one

* Mr. George Clarke, in "Annals and Magazine of Natural History."

having as many as seven. The kernel contains a portion of oil, but its excessive hardness, and the difficulty of detaching it from the shell (itself so valuable), render it practically useless for oil manufacture. The shell is about equal in hardness to that of the ordinary cocoa-nut, and as susceptible of a fine polish. It is from one-tenth to three-sixteenths of an inch in thickness.

A fixed oil (called Manteiga de Assahay) is extracted by decoction from the fruit of the *Euterpe oleracea* palm, which abounds in Para. The oil is of a greenish colour, slightly bitter, and used for lighting and other purposes.

The pulp of the fruit of the Aoura palm, of Guiana (*Astrocaryum vulgare*), yields an oil which is used for many different purposes. A yellowish, bitter oil, used for soap-making in Brazil, is obtained by decoction and expression from the fruit of the *Sagus taedigera*, which is abundant in Para.

From the nuts of *Œnocarpus Bacaba*, a palm also abundant in Brazil, an oil of a clear green colour is obtained, which, when purified, is used for lighting and culinary purposes. From the fruit of other species—*O. Bataua* and *O. distichus*—fluid oils, clear, yellow, and transparent, are procured, which, when purified, are inodorous, and used in cooking in place of olive oil.

There are two or three species of *Carapa*, the nuts of which yield a fixed oil. Crab oil of Guiana is from the *Carapa guianensis*, which yields 33 per-cent. It is extremely bitter, but used externally for the hair and for soap making. It is abundant in Para, where

it is known as andiroba oil. The nuts are so common in some of the districts of French Guiana that, when they are ripe, the soil is covered at least a foot deep with them for many hundreds of yards. That of Africa, known as mote grease, obtained from mote or kundoo nuts, is from the *Carapa talicoonah* or *touloucouna*, which yield 70 per cent.

The nuts of some other plants yield a large amount of oil, especially the *Bassias* and the *Argan* of Morocco (*Argania Sideroxylon*).

The shea butter or solid oil from the Niger, is obtained from the fruits of *Bassia Parkii*, by boiling them in water. The yield of oil is about 30 per cent. The fruit of another species (*B. longifolia*) furnish by expression in India the Elloopie or Mee oil, which is used for lamps among the poorer classes, and is one of the principal ingredients in making country soap. It is of a clear yellow, depositing stearine, density ·912. The seeds of *B. latifolia* yield by expression a large quantity of concrete oil, called Madooka, which is used in lamps, and for other purposes. The kernels are easily extracted from the smooth, chesnut-coloured pericarps, when they are bruised, rubbed, and subjected to a moderate pressure. The oil concretes immediately it is expressed, and retains its consistency at a temperature of 95°. It is used locally for the manufacture of soap; is usually of a greenish-white colour, and has been imported into this country, under the name of Mohwa oil, from Calcutta.

From *B. butyracea* a pure vegetable oil is produced, called choorie and galam butter. The kernels of the fruit are bruised, put into a cloth bag with a mode-

rate weight laid upon it, and left to stand till the oil is expressed, which becomes of the consistence of lard, and of a delicate white colour. It is considered a valuable preservative when applied to the hair, mixed with some sweet-scented oil. It makes excellent soap, and, when pure, burns bright, without smoke or smell.

There are one or two species of *Bassia* found at Gaboon, yielding 56 per cent. of oil. One, *B. gabonensis*, contains a true vegetable fat, of which two varieties are made, one called "noungu" by the natives, which has the consistency of goose fat, comestible; the other, named "djave," is only available for the preparation of soap.

The Borneo concrete vegetable tallow of commerce, judging from the cotyledons of seeds received, would seem to be from one of the *Bassias*. The fat is made up into large, round, flattened cakes, of the consistence and colour of cheese, and also cylindrical masses, which have assumed the form of the bamboo sections into which it had been poured when in a liquid state.

The nuts of *Cola edulis*, a *Sterculia* in Western Africa, yield 63 per cent. of stearic oil. The Booma nut of Central Africa much resembles an almond, both in shape and size, and with the fleshy covering is about the size of a walnut. It is probably the fruit of a species of *Vitex*. It furnishes an abundance of sweet bland oil, much used by the natives in their cooking.

In Jamaica a fine limpid oil is obtained from the bread-nut (*Omphalea triandra*, the *O. nucifera* of Schwartz), but whether it will bear a low degree of temperature without congelation has yet to be ascer-

tained. From another species an excellent oil is produced in Guiana, called Ouabe, which is suitable for lubricating machinery.

Ground-nut oil is an important trade article, and the seeds enter largely into commerce.

The plant which produces the ground-nut (*Arachis hypogæa*) is a little annual, one of a class which bury their pods in the earth when they ripen, instead of raising them into the free air. Having buried itself sufficiently deep, the pod then begins to swell, and when ripe becomes an oblong, rugged, pale brown fruit, containing usually about two seeds, as large as the kernel of a hazel nut. It is now found in a state of cultivation all over the hottest part of the tropics. It was unknown until the discovery of America, and every region in the old world where it is now grown owes it to Brazil; so that we have in this plant a further example of the rapidity with which vegetables will take possession of soils where the climate is suitable, for it is now grown very generally in different parts of Africa, in India, the West India Islands, and the United States.

The ground-nut, the staple product of the Gambia, is principally cultivated down the borders of the river. In 1837 the export was but 671 tons, valued at £8,000, but it has gone on annually increasing, for in 1860 it was 11,200 tons. The natives have unfortunately introduced of late years the pernicious system of beating or thrashing, instead of picking by hand, so that the nuts are mixed with leaves, stones, and other extraneous substances, causing large deductions in the French market, and also depreciating their

value in the United States, as an article of food, or rather as a favourite repast for the tables of the rich.

In Brazil it is known under the name of "amendoum," and has long been used there parched for food and to extract oil from. This oil is used for cooking, medicinally for rheumatic affections, and for lighting.

The roasted seeds are sometimes used as a substitute for chocolate; and, according to Dr. Davy, they abound with starch as well as oil, a large proportion of albuminous matter, and in no other instance had he found so great a quantity of starch mixed with oil.

Dr. Muter, in an article in a popular periodical this month, April,—"The Food Journal,"—after giving the following analysis of ground-nut meal, urges strenuously its more general use as an important article of food:—

Moisture	9·6
Fatty Matter	11·8
Nitrogenous Compounds (flesh formers)	31·9
Sugar, Starch, &c.	37·8
Fibre	4·3
Ash	4·6
	100·0

"From this analysis it is evident," observes Dr. Muter, "that the residue from them, after the expression of the oil, far exceeds that of peas, and is even richer than lentils in flesh-forming constituents, while it contains more fat and more phosphoric acid than either of them. On these grounds we are justified in urging the adoption of the ground-nut meal as a source of food, it being superior in richness of all important constituents to any other vegetable

product of a similar nature. Although in the raw state it possesses a somewhat harsh odour, similar to that of lentils, this flavour entirely passes off in the cooking, and when properly prepared we consider that it has a very agreeable flavour. It has been tried in three forms:—First, boiled plain with water, like oatmeal porridge, and eaten with milk; second, made into a custard, with sugar, milk, and one egg to the pint; and third, washed, ground, and taken as a beverage, like cocoa. In all these three forms, but especially in the two latter, it was exceedingly palatable."

This seed is held in much estimation when parched in the United States; it is there known as the pea-nut.

There are fully 550,000 bushels sold annually in the city of New York alone. Previous to 1860, the product of the United States did not amount to more than 150,000 bushels, and of this total nearly five-sixths were from North Carolina. Now, North Carolina produces 125,000 bushels; Virginia, 300,000; Tennessee, 50,000; Georgia and South Carolina, each 25,000 bushels; while from Africa come about 100,000 bushels a year. In one week of the month of January, 1871, there were received at the port of New York, 2,751 bushels.

Another underground seed, passing under the names of rush nuts, ground pistachio-nuts, chufas, souchet, &c., is *Cyperus esculentus*, the *amande de terre* of the French. They are eaten like nuts, being nutritive, restorative, and stimulant, and are also employed in the preparation of orgeat, a refreshing drink. The roasted roots have been used as a substitute for coffee,

and yield a preparation resembling chocolate. In this country we have an earth or pig nut (*Bunium denudatum*, Decandolle), which being aromatic, sweet, and mucilaginous, might form occasionally an addition to our winter desserts, eaten raw, boiled, or roasted.

Under the name of candle-nuts, some considerable quantities of the seeds of species of *Aleurites*, an euphorbiaceous tree, now come into commerce. They are known to the French as bancoul nuts; in the Pacific Islands they are called kukune. The natives of India are fond of the nut, which is said to be palatable, and something like our walnuts. It yields, by pressure, an oil of a density of ·923, which has various uses. It forms a good oil for painters, for, after boiling, it dries in about six hours. It is used for soap-making at Tahiti, in the place of cocoa-nut oil. It burns without that objectionable smell which cocoa-nut oil has, and gives a good light without injuring the lamp. It is used also as a drastic purgative. At Nukahiva the nuts are skewered together for lighting at night. The first burns for about ten minutes and communicates to the others, so that a row of twenty-four will last for about four hours. In the Marquesas and other islands, however, this mode of illumination is giving place to whale oil, purchased from the whale ships.

In the history of the "Mutiny of the Bounty" it was stated that the rooms in Pitcairn's Island were lighted up by torches made of doodoe nuts (*Aleurites triloba*), strung upon the fibres of a palm leaf, forming a good substitute for candles. These nuts are also so strung and used by the San Blas Indians in Central

America, and a child is in attendance to knock off each nut as it becomes burned out.

By hydraulic pressure of 20 horse-power, 60 per cent. of oil can be obtained from the kernel of these nuts, but the shell has to be removed by heat or steam, being exceedingly hard to crush. 100 kilogrammes of the nuts yield 33 kilogrammes of the kernels, and 100 kilogrammes of these, with powerful pressure, will yield fully 66 per cent. of oil. The marc or oil-cake left is good for feeding cattle, or for manure. There is a species indigenous to the Eastern Archipelago (*A. moluccana*), the oil of which is said to be used for culinary purposes in Java, which results probably from a more careful mode of preparation.

In China another species of *Aleurites* (*A. cordata*) known as the Tungshu tree, yields such an abundance of oil, that it is said to be one of the largest products of the province of Szechuen. In point of quality it is inferior to that of the Camellia, but it is very extensively used for lighting purposes. The natives call it Tung oil.

Beech nuts, the seed or fruit of *Fagus sylvatica*, serve to feed swine on now in forests; but before the general cultivation of cereals they were, like acorns, the food of uncivilised men; dried and ground into meal they make a wholesome bread; roasted, they form a tolerable substitute for coffee. A clear, yellow, inodorous oil is obtained from them in France; a bushel of beech mast will produce about a gallon of oil, or the yield may be said to be 12 to 15 per cent. of oil. In some parts of the Continent this oil is used instead of butter for culinary purposes. In the reign

of George I. a petition was presented, praying letters-patent for making butter from beech nuts. It is a pity some wholesome vegetable fat cannot be brought into commerce in the present day, when butter is so dear and so bad. A beech-oil company was one of the most noted commercial speculations of Queen Anne's reign.

In Brazil, the fruit of *Myristica Bicuhyba*, Schott, yields a concrete oil, of a brown colour, which is employed in cases of asthma, rheumatism, tumours, &c.

A quantity of the small oil-nutmegs (*Myristica sebifera*) have lately been imported. The seeds bruised and pressed by heat give 26 per cent. of a substance entirely soluble in potash water, fusible at 34·5, and composed of two parts of oil, one neutral and the other acid, the last forming about three-fourths of the mass. The neutral part, having glycerine for its base, forms a solid soap with soda. This oil is well adapted for candles; the nut is very abundant in South America, and deserves the attention of business men.

Physic nut is a name for the seed in the capsules of *Jatropha Curcas* and *J. multifidas*, which furnish an oil used for lighting and in medicine. It has the same qualities and uses as croton oil, but in large doses is a dangerous poison. The oil is largely used in Indian camps. It is odourless, of a deep yellow, and viscous, but burns well. When cold it deposits a considerable quantity of stearine; density ·918. It is largely produced in the Cape Verde Islands, from whence nearly 300,000 bushels are annually shipped.

3. Turnery Nuts and Ornamental Seeds. Of nuts

for turnery and ornament there are not many received in this country, but a few have some degree of commercial importance, and one or two others may be incidentally noticed.

Our Continental neighbours seem to be more shrewd and clever than we are in applying nuts and seeds to purposes of personal decoration, and although from being cheap, many of these ornaments are despised by our belles, yet none can deny their interest and beauty, and the ingenuity and taste with which they are arranged. The field is an exhaustless one, and many well-known ornamental nuts and seeds of India and South America have not yet made their appearance in this country.

The vegetable ivory nuts of commerce, "corosso nuts" as they are usually termed, and "tagua" by the Indians of Magdalena, are the fruit of the *Phytelephas macrocarpa*, a South American palm. The fruit, a collection of from six to seven drupes, forms clusters which are as large as a man's head, and stands at first erect, but when approaching maturity, its weight increasing, and the leaf stalks, which up to that period supported the bulky mass, having rotted away, it hangs down, and the creeping caudex is seldom higher than six feet. A plant bears at one time from six to eight of these heads, each weighing, when ripe, about twenty-four pounds. The drupes are covered outside with hard woody protuberances. Each contains from six to nine seeds, but generally seven. From the kernels (the hardened albumen) the European turners fashion the knobs of walking sticks, the reels of spindles, small boxes, and various little toys. It is of the

same nature as the nutmeg and the pulp of the cocoa-nut, which in some palms becomes more hardened. That of the date, the *Sagus vinifera*, the talipot palm, and others, is quite as hard, but is neither large enough nor white enough to be of much use to the turner. In contact with sulphuric acid the vegetable ivory takes a splendid red colour, almost equal to magenta. This colour, at first pink, then bright red, becomes much deeper and more purple when the acid has been allowed to act for about twelve hours.

The demand for vegetable ivory nuts is largely on the increase, for button making and other purposes—as much as a ton a day is frequently worked up in Birmingham. In 1870 we received 31,430 cwts., valued at about £20,000.

The waste and shavings of this nut furnish a good charcoal, which is utilised by some chemists. A paragraph has lately been going the round of the papers, stating that the turnings and raspings of the nut are used to adulterate ground bones for manure. But this I much question, as the refuse could scarcely be obtained in any great quantity. The value of the other nuts imported for turning, &c. (besides the vegetable ivory nuts), is about £20,000.

The coquilla nut, the fruit of *Attalea funifera*, one of the palms which yield the piassaba fibre of commerce, is another ornamental turning nut, but of a rich veined mahogany colour. The supplies, however, from South America have been failing, owing to the indiscriminate destruction of the trees, and the nuts imported lately have been small and immature, and, therefore, not appreciated or useful. The cohune

nut, from another species of the same palm, can also be turned into little articles. In Bogota they have small nuts, exceedingly hard, called toparos, which are often made into tinder-boxes, adorned with silver.

The seeds of the shreetaly, or talipot palm (*Corypha umbraculifera*), being a species of vegetable ivory, are turned into marbles, beads used by certain sects of Hindoos, button moulds, and various minute articles. Little bowls and other fancy ornaments are made from them, and when polished and coloured they are easily passed off for genuine coral. These nuts could be obtained in large quantities in Canara, Malabar, and other parts of India; the chief objection to them is that they are of such small size.

The fruit of the doom palm is turned into beads for rosaries, and, in Africa, is made into little oval-shaped cases for holding snuff.

The betel nut, the produce of the *Areca Catechu* palm, may here be incidentally mentioned, because it has been turned into ornamental articles, although its principal uses are for other purposes. Small quantities are imported for making tooth-powder and paste, and as a dog medicine; but in India a large commerce is carried on in this nut, chiefly as a masticatory; catechu is also made from it. Betel nuts are pale when mature, but dark-coloured when collected and dried in an immature state, hence the distinction of red and white nuts in the Eastern bazaars, the former being only half the value of the latter. About 4,000 tons of these nuts are annually shipped from Ceylon to different quarters. At Travancore the quantity grown is enormous; in Penang 3,000 tons are produced, and in Sumatra 4,000 to 5,000 tons.

The nuts of various other palms have some few useful applications. The grugru nuts, the seed of *Acrocomia sclerocarpa*, are turned and carved into very pretty beads, rings, and other small articles, the hard black texture of the nut taking a fine polish.

The speckled albuminous fruit of *Sagus Raphia* or *vinifera* are carved into little figures by the African negroes.

Peach, cherry, and other fruit stones are often seen carved and highly ornamented, and made into rosaries, bracelets, &c., evidencing the patience and skill of the workman who has laboured on them; the hard stones of the date plum, and other indigenous fruits, are frequently beautifully and elaborately carved by the Chinese and Japanese.

Under the name of Quandung nuts, the corrugated seeds of the Australian native peach (*Santalum acuminatum*), are often set and mounted for scarf pins, bracelets, and other ornaments.

The spherical, corrugated seeds of *Elæocarpus Ganitrus*, and other species, cleared of their soft pulp, are used by the Brahmin priests as beads. They are also made into necklaces and bracelets for ladies, which are much admired, especially if gilded or capped with silver mountings. Those of *Monocera tuberculata* are used for a like purpose in Travancore. The nuts of *Putranjiva Roxburghii* (the wild olive), called in Hindostan "Jeeopatra," are strung by the natives, and put round the necks of their children as an amulet.

The seeds of the bladder-nut (*Staphylea pinnata*) are as hard as bone. The nuts, in some parts of Europe, are threaded for paternosters, and made into

necklaces and chaplets. They are also called cut-noses and false pistachios. The kernel has a little of the flavour of the pistachio, but is very acrid, and occasions nausea if eaten to any extent. It yields by expression a bland oil.

The hard nut of the fruit of the dwarf palm (*Chamærops humilis*) is, in Algeria, turned to make chaplets, bracelets, and necklaces, which are esteemed for the pretty veins of all colours.

4. Miscellaneous Nuts. In this last group I may include the nuts used for tanning and other purposes. Among the tanning and dyeing nuts or seeds are, valonia, under which name the large acorn cups of *Quercus Ægilops* are imported from Turkey; the incipient acorns being called camata and camatina. In 1859, 25,579 tons, valued at £332,527, were imported; last year (1871) 27,706 tons, worth £441,998, were received. Under the name of myrobalans, the dried fruit of some species of *Terminalia*, chiefly *T. Chebula*, are imported, sometimes to the extent of 6,000 tons in the year. In 1870, 3,000 tons, valued at £33,000, were imported. One species sometimes comes in under the name of Bedda nuts. From its astringent properties, the dried fruit is much used by the Hindoos in their arts and manufactures. The outer coat of the fruit, mixed with sulphate of iron, makes a very durable ink; hence they are called in the bazaars of India ink nuts.

The Belleric myrobalan (*T. Bellerica*, Roxburgh) is also astringent, and sometimes used in medicine in the East. The kernel of the nut mixed with honey is given in certain cases of ophthalmia. It is said to intoxicate if eaten in great quantity. An oil expressed from the seed

is used in India for strengthening the hair. The kernel of the nuts of another species (*T. Catappa*, Linnæus) has the flavour of an almond, and may be used for the same purposes. The oil is very like the almond oil of Europe, both in taste and smell, but becomes turbid by keeping. It only requires care and attention in its preparation to render it of commercial value and importance. To extract the oil, the fruit is gathered and allowed to dry in the sun for a few days, when the kernels are cleaned and bruised in a mill.

Nutgalls, the spherical concretions and excrescences formed upon the leaves and leaf stalks of several species of oak and other trees in the south of Europe, are made by the puncture of the female gall fly. There are blue, black, green, and white galls; the last are of little value. Those from Aleppo and Mosul are the best; they are about the size of a nutmeg, and mostly of a bluish or greyish colour, hard, heavy, compact, with numerous small tubercles on their surface. The imports in 1870 were 17,748 cwts., of the value of £54,169.

Grey Bonduc nuts, sometimes called Nata in India, and in Barbados the horse nicker or chick stone, are the stony seeds of *Guilandina Bonduc*. They are intensely bitter, and have hence some medicinal reputation. They are used for playing a game in Western Africa. Ornaments formed of them are very common in museums, and I have seen baskets, bracelets, rosaries, and other articles made with them.

The cola nuts of Western and Central Africa, the seed of *Sterculia acuminata*, have attracted some attention from their use in food and medicine by the natives; and after careful analysis, Dr. Attfield found

they contained 2 per cent. of theine, which is more than the average in tea and coffee.

The poison nut, or ratsbane, the seed of *Strychnos nux vomica*, is contained in a pulpy fruit, about the size of an orange. As a medicinal agent these seeds possess valuable qualities, but are highly poisonous, except in very minute doses. What is done with the 5,000 or 6,000 cwts. imported it is difficult to say.

The seed of another species (*S. potatorum*), the clearing nut, has more useful properties, for they are employed in India to clear muddy water. One of the seeds is well rubbed round the inside of the earthen vessel containing the water, which is then left to settle; in a short time the impurities fall to the bottom, leaving the water clear and perfectly wholesome.

The marking-nut, the fruit of *Semecarpus Anacardium*, is in general use in India for marking clothes with the juice of the pulp; the colour is improved and preserved from running by the mixture of a little quicklime and water.

Under the name of soap-nuts, the round, black seed of *Sapindus Saponaria*, *S. emarginatus*, and some other species are much used for rosaries, necklaces, bracelets, and other ornaments.* They derive their name of soap berries from the acrid saponaceous pulp being used for washing linen. The kernels of *S. esculentus*, are eaten in the West Indies, and deemed as palatable as the hazel nut or almond.

* A long descriptive article of mine "On Some Economic Uses of Nuts and Seeds" will be found in "The Technologist," vol. iv, p. 339

Horse chesnuts are much used on the Continent for making starch, and an oil is said to be obtained from them which is sold by some chemists as a sedative in gout.

The drupe of the wild almond of the Cape (*Brabeium stellulifolium*, Linnæus), after having been soaked for some days in water, is eaten by the natives, being considered injurious when quite fresh. The kernel when roasted is used as coffee.

Ravensara nuts are the aromatic fruit of *Agathophyllum aromaticum*, one of the laurel family, of Madagascar; they are used sometimes instead of nutmegs.

Sassafras nuts, another aromatic seed, are the isolated lobes of the seeds of *Nectandra Puchury*.

Cumaru nuts of Brazil and Guiana are the seeds of *Dipterix odorata*, the tonquin bean of commerce, which yields a pleasant perfume for snuff, clothes, &c. A clear, yellow, fixed oil is obtained from them, which is used in perfumery and for ulceration of the throat.

I have thus taken a hasty survey of nuts and their products, necessarily, from the wide field I have had to cover, very superficial; but I think those who have followed me in my investigation will admit that it is an interesting subject of enquiry, and that the commercial uses of nuts and their products are of considerable importance in this and other countries.

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ERRATA.

Page 76, line 12 from bottom, *for* £269,460,124, *read* £295,460,124 as given on previous page.

Page 520, *for* Total £1,625,544, *read* Total £1,725,544.

Page 550, *for* Total £30,283,000, *read* £30,783,000.

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